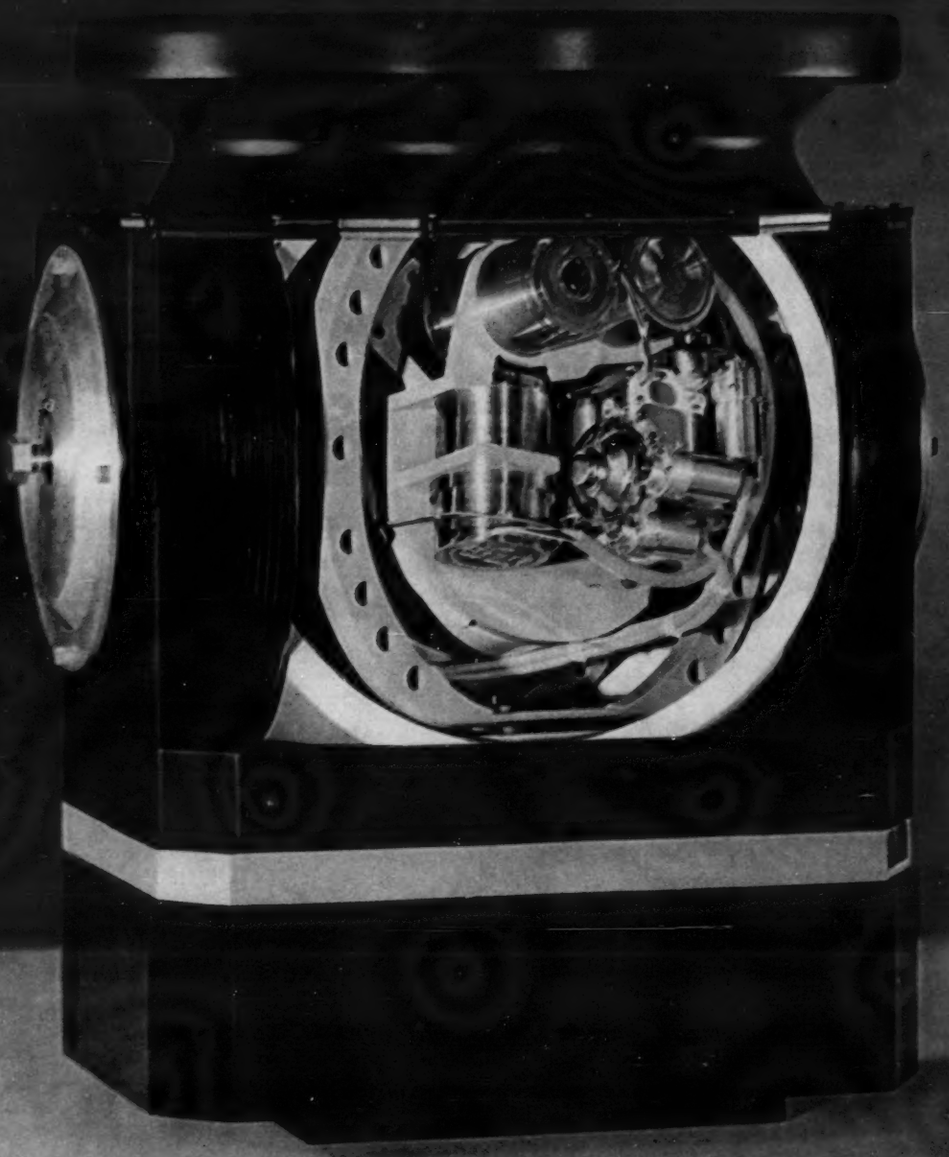
Design News

DESIGN MATERIALS



Thermally-matched materials improve gyro precision. Page 1

A CAHNERS PUBLICATION

SEPTEMBER 29, 1961

NATIONAL BUD* OIL SEALS

OVER 3,500 DIFFERENT SIZES IN PRODUCTION

BUD (Bonded Universal Design) Oil Seals field-proved in over 20 million cars, trucks and buses. Economical, ready when you need them.

National has complete tooling to provide you with a broad range of dependable BUD® seals covering virtually 100 shaft sizes for standard applications.

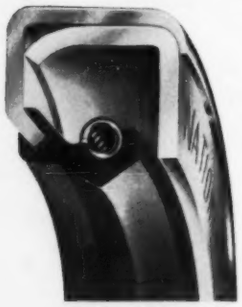
National 410,000

In National BUD seals, the lip is permanently bonded to the metal casing. This means less rubber needed, less frictional heat at contact points, longer life, less space required in applications. Bonded design eliminates internal leakage, and BUD seals are phosphate coated to avoid rust. With these features plus superior concentricity and rugged, simple design, BUD seals have proved outstanding in many millions of hours of widely varied field usage.

Available with single or dual lips; in single case design for standard precision shaft sealing, or double case design for heavy duty use of severe press fit. Sealing materials are available for temperatures from —80°F to +400° F, to operate in most oils or industrial fluids.

The bonded design was pioneered at National Seal—industry's oil seal headquarters for 40 years. If yours is a standard application, your National Seal field engineer has the proper BUD seal for prompt delivery; if yours is a special design his experience can help you cut sealing costs. He's listed in the Yellow Pages, under "Oil Seals."

National 470,000



National 450,000

New 20-page National Catalog 61-B lists BUD seals available now. Write for your copy today.

National 480,000

NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio; Downey and Redwood City, California

*BUD (Bonded Universal Design)

7320

Circle 1 on Reader-Service Card for more information

STAFF

John P. Dubois, *Executive editor*

Kurt F. Kircher, *Managing editor*

W. E. Worth, Jr., *Associate editor*
P. R. Taylor, *Associate editor*
D. M. Proctor, *Editorial assistant*

V. W. Wigotsky, *Eastern editor*
E. J. Stefanides, *Central states editor*
L. G. Soderholm, *Midwest editor*
E. W. Schrader, *Western editor*
C. W. Lowe, *Mgr., European division*
R. W. E. Martin, *British editor*
C. O. Lubatti, *Italian editor*
R. F. Stengel, *German editor*

W. E. Hemphill, *Art director*
E. G. Batmanglidj, *Editorial assistant—layout*
A. W. Hulitzky, *Production manager*
M. J. McLain, *Quality control*

Foreign Correspondents

G. B. Bernard, *France*
V. Holmboe, *Sweden*

Editorial Offices

Englewood, Colorado
3375 S. Bannock Street
SUnset 9-0571

Chicago 6, Illinois
20 N. Wacker Drive
CEntral 6-7883

Detroit 19, Michigan
19600 W. McNichols Road
KEnwood 7-3740

Los Angeles 48, California
6399 Wilshire Boulevard
OLive 3-9720

New York 17, New York
60 E. 42nd Street
YUkon 6-2030

Pittsburgh 22, Pennsylvania
1 Gateway Center
ATlantic 1-8822

Milan–San Giuliano Milanese, Italy
Via G. Carducci (Borgoest)
Melegnano 346

Munich 22, Germany
Thierschstrasse 15
Tel. 29 48 26

Zurich 1, Switzerland
Talstrasse 65
Tel. 27 86 50

Copyright 1961 by Rogers Publishing Co., Inc., A Subsidiary of Cahners Publishing Co., Inc.

Postage Will Be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY MAIL

FIRST CLASS PERMIT No. 381, Sec. 34.9 P. L. & R., ENGLEWOOD, COLORADO

Reader-Service Department

Design News

ENGLEWOOD, COLORADO

ADVERTISEMENTS

1	2	3	4	5	151	152	153	154	155
6	7	8	9	10	156	157	158	159	160
11	12	13	14	15	161	162	163	164	165
16	17	18	19	20	166	167	168	169	170
21	22	23	24	25	171	172	173	174	175
26	27	28	29	30	176	177	178	179	180
31	32	33	34	35	181	182	183	184	185
36	37	38	39	40	186	187	188	189	190
41	42	43	44	45	191	192	193	194	195
46	47	48	49	50	196	197	198	199	200
51	52	53	54	55	201	202	203	204	205
56	57	58	59	60	206	207	208	209	210
61	62	63	64	65	211	212	213	214	215
66	67	68	69	70	216	217	218	219	220
71	72	73	74	75	221	222	223	224	225
76	77	78	79	80	226	227	228	229	230
81	82	83	84	85	231	232	233	234	235
86	87	88	89	90	236	237	238	239	240
91	92	93	94	95	241	242	243	244	245
96	97	98	99	100	246	247	248	249	250
101	102	103	104	105	251	252	253	254	255
106	107	108	109	110	256	157	258	259	260
111	112	113	114	115	261	262	263	264	265
116	117	118	119	120	266	267	268	269	270
121	122	123	124	125	271	272	273	274	275
126	127	128	129	130	276	277	278	279	280
131	132	133	134	135	281	282	283	284	285
136	137	138	139	140	286	287	288	289	290
141	142	143	144	145	291	292	293	294	235
146	147	148	149	150	296	297	298	299	300

NEW PRODUCTS

301	302	303	304	305
306	307	308	309	310
311	312	313	314	315
316	317	318	319	320
321	322	323	324	325
326	327	328	329	330
331	332	333	334	335
336	337	338	339	340
341	342	343	344	345
346	347	348	349	350
351	352	353	354	355
356	357	358	359	360
361	362	363	364	365
366	367	368	369	370
371	372	373	374	375
376	377	378	379	380
381	382	383	384	385
386	387	388	389	390
391	392	393	394	395
396	397	398	399	400
401	402	403	404	405
406	407	408	409	410
411	412	413	414	415
416	417	418	419	420
421	422	423	424	425
426	427	428	429	430
431	432	433	434	435
436	437	438	439	440
441	442	443	444	445
446	447	448	449	450

(Please do not abbreviate)

Name_____

Title_____

Company_____

Division_____

Address_____

City_____ State_____

Design News, September 29, 1961
This Card Good Until
December 4, 1961

LITERATURE

451	452	453	454	455
456	457	458	459	460
461	462	463	464	465
466	467	468	469	470
471	472	473	474	475
476	477	478	479	480
481	482	483	484	485
486	487	488	489	490
491	492	493	494	495
496	497	498	499	500
501	502	503	504	505
506	507	508	509	510
511	512	513	514	515
516	517	518	519	520
521	522	523	524	525

☐ Employment ads—please give home address

_____

_____

_____

_____

_____

FREE REPRINTS

526	527	528	529	530
531	532	533	534	535
536	537	538	539	540
541	542	543	544	545

OTHERS

546	547	548	549	550
551	552	553	554	555
556	557	558	559	560
561	562	563	564	565

MAIL THE CARD TODAY

Design News

Sept. 29, 1961 Vol. 16 No. 20

4 Special Reports

4 Elastomeric Suspension Systems for Shipping Containers
6 Structural Adhesive Joint Design
8 Design Criteria and Applications for Thermoplastic Bearings

12 Design Ideas . . . Materials

12 'Matched' Materials and Moving Copper Conductors Improve Gyro Precision (Cover)
14 Magnesium Extrusion Provides Stability without Loss of Speed
16 Sandwich Gives Bending Stiffness to Saturn Interstage Fairing
18 Rear Suspension of Chevy II Uses Single-Leaf Springs
20 'Delrin' Arc Chute Provides Self-Extinguishing Load-Break Action
22 Rectangular Tube Increases Rigidity of Scraper Plane
24 Polyurethane Foam Simultaneously Isolates Shock and Vibration
28 Titanium Impeller Adapts Pump to Corrosive Service
30 Powder Metallurgy Parts Silence Machine Operation
32 Asbestos-'Teflon' Packing Prevents Valve Leakage
34 Ammonia Valve Uses Ductile Iron for Greater Capacity
36 Stretch-Formed Aluminum Adds Round Corners on Trailer
38 Molded 'Lexan' Modules Improve Display on Lighted Pushbutton Switch
42 Activated Carbon System Permits Volatile Solvent Recovery
44 Friction-Bonded Cast-Iron Ring Eliminates Field Failures
46 Miniature Dimples Lock Gasket Material to Metal Core

52 Design Ideas . . . Electrical

52 Ceramic Magnets Replace Field Structure, Raise Output of D-C Motors
54 Parallel Resonance Circuit Checks EBW Squib

57 New Products

57 Materials 96 Mechanical 100 Electrical 104 Equipment

65 Design Data

65 Titanium

112 Design Ideas . . . Mechanical

112 Rubber Cylinder in Square Box Provides Progressive Elastic Properties
114 Timing-Belt Gear Pump Provides Increased Capacity

124 Design Ideas . . . Controls

124 Air Nozzles on Floating Beam Increase Accuracy of Pneumatic Gaging Machine

130 Ideas in the News

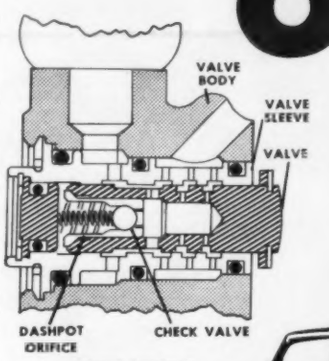
'Matched' Materials and Moving Copper Conductors Improve Gyro Precision . . . Page 12

2 Sounding Board
3 Design Views
10 Seen and Heard
48 Patents
116 New Literature
120 Technical Papers
126 New Books
148 Index of Advertisers
150 Product Index
152 Plans and Cross Sections

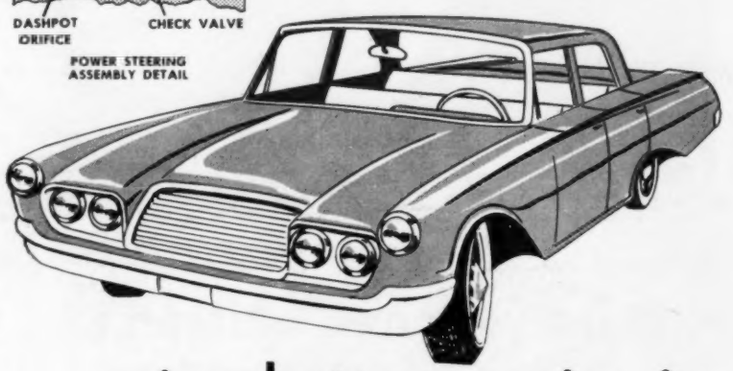
Published bi-weekly by Rogers Publishing Company, Inc., a Subsidiary of Cahners Publishing Company, Inc. Editorial, Advertising and Subscription Offices: 3375 S. Bannock St., Englewood, Colorado. Telephone: SUnset 9-0571. Printed at 85 W. Harrison St., Chicago, Illinois. Accepted as Controlled Circulation Publication at Chicago, Illinois. Send form 3579 to Subscription offices.

MINNESOTA MR RUBBER

INJECTION MOLDED O-RINGS



- TOP SEALING EFFICIENCY
- HIGH DENSITY
- WEAR RESISTANT
- CUSTOM COMPOUNDS



. . . give better service in any application

TOP SEALING EFFICIENCY is possible because Minnesota Rubber injection molding virtually eliminates flash and variations in part thickness.

HIGH DENSITY means longer seal life because it gives the O-rings outstanding resistance to chemicals and abrasion.

WEAR RESISTANT injection molded O-rings don't wear and extrude as easily as ordinary seals. They reduce replacement and loss of production due to downtime.

CUSTOM COMPOUNDS from Minnesota Rubber insure outstanding service because the O-ring will be made from the best material for your application.

FOR MORE INFORMATION ON INJECTION MOLDED **O-RINGS** → *WRITE*

NFPA

MINNESOTA MR RUBBER

DEPARTMENT 432 • 3630 WOODDALE AVENUE
MINNEAPOLIS 16, MINNESOTA

Circle 2 on Reader-Service Card for more information

DRAFTING TRENDS

New, improved Rotolite Expeediter conveniently makes sepia reproducibles and diazo films in addition to low cost whiteprints.

Make your own whiteprints in two minutes or less

Here's a new, fast, economy whiteprinter that fills a real need in small drafting rooms or large engineering departments.

Workprints for architects, consulting engineers, surveyors, contractors. The Rotolite Expeediter can handle *all* copying needs for the two- or three-man drafting operation, is always ready to cope with rush jobs, even after hours. With POST Super Vapo Papers, print production can be doubled.

Quick checkprints for larger manufacturers. Even huge, multi-department engineering divisions with their own reproduction departments or outside sources praise Expediter's practical, on-the-spot convenience for quick copies of preliminary sketches, checkprints, conference data, visual presentations. Hundreds of companies have placed Rotolites advantageously in each of their several engineering and drafting rooms for "self-service" whiteprints in a hurry.

No preheating or other delays—Rotolite makes prints immediately. There's a choice of three models to take 18", 27" or 42" wide tracings of any length. Furnished with dry-developing ammonia tube. Rotolite is easily hung on wall or placed flat on a table top, plugs into any standard convenience outlet. With new dial speed control, you can make cloth and film reproductions immediately, as well as paper prints. Provides clean, sharp prints every time through simple design, durable construction. Single lamp simplicity is entirely adequate for every "quick print" need.

Recommended print materials. Use POST diazotype sensitized products —Vapo paper, sepia vellum, cloth or film—for best results. Get full information on Expeediter and standard Rotolite whiteprinters from your POST dealer or write Frederick Post Company, 3650 N. Avondale Avenue, Chicago 18, Ill.

POST

SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

Circle 3 on Reader-Service Card for more information

SOUNDING BOARD

FOR OUR READERS

Conversion Tables

About 10 days ago I received the two clippings of our "Instant Conversion" tables (DESIGN NEWS, August 18 issue). While I have not been on your mailing list for the last few years, I still have the opportunity to read my Boss' copy. He had left it on my desk on Friday, the day before I received your clippings. I had not read as far as the "New Books" section, so did not know of it until the clippings arrived.

I have had several comments locally on the article. Almost as soon as the article had appeared, I received a letterhead, the clipping and a dollar bill in the mail. I have also received several single orders from around the country that must be the result of the article.

We want you to know that we greatly appreciate the article. The many recent orders prior to the article have proven that our tables are valuable to industry, and we are glad that your magazine saw fit to inform your readers of its existence.

JOE PENN
4910 Carson Ave.
Indianapolis 27, Ind.

• It's nice to know readers are interested in the "New Books" department.

Decline and Fall

Your quip, in answer to Mr. Hellinger's letter printed in August 4 issue of DESIGN NEWS, deserves attention.

The antiquated method of selection of persons to run for public office only permits you to vote for one person who is "nominated" by a relative few. Not only the method of selection leaves much to be desired, but, in the case of the highest office in the land, the electoral college can change (and has done so) the selection of the majority.

It's high time that WE elect our politicians.

NICHOLAS G. CRISTY
Chief Engineer
Macton Machinery Co., Inc.
Stamford, Conn.

• But these things won't be changed unless WE want them changed.

Guide to Technical Literature Production

Please accept my thanks for your very kind editorial review of my book "A Guide to Technical Literature Production".

Book-writing in the technical field is not a lucrative activity; however, I find the reward to be in the realization that some of my words might be helpful to some "engineering guys with a problem".

EMERSON CLARKE
851 Bennett St.
Geneva, Ill.

Engineer in a Cocoon

Thank you for publishing my letter in DESIGN NEWS. It has certainly stirred up a hornet's nest.

A surprising number of engineering people agree with my observations.

If possible, make one correction—you had me sitting management at the drafting board. This was not in my original letter.

I did mention management but only in the sense that it was their responsibility to see that engineers spend a long enough time working at the drawing board.

NICHOLAS C. LUTZ
Singer Mfg. Co.
Elizabeth, N. J.

"Doesn't anybody disagree with us anymore?"

Emphasis: Materials

"Design Materials" are the words appearing on our cover. As announced in the previous editorial, the emphasis in this issue is all on materials and their uses in design.

You will see many innovations. We have three Special Reports this time, all of which pertain to design engineering with the right materials. The first, on elastomeric suspension systems for shipping containers, is a reminder of a function which is often overlooked in engineering. There is no point in building a good product, then having it smashed in transit to the customer. The article on structural-adhesive joint design should prove to be of interest to engineers in widely dispersed fields. While somewhat more specialized, the article on plastic bearings opens up some interesting possibilities for design with materials not ordinarily considered for bearing applications.

We have started the Design Idea sections with materials this time—specifically with the cover article. It is the wise choice of materials that makes this integrating gyro such an accurate piece of machinery.

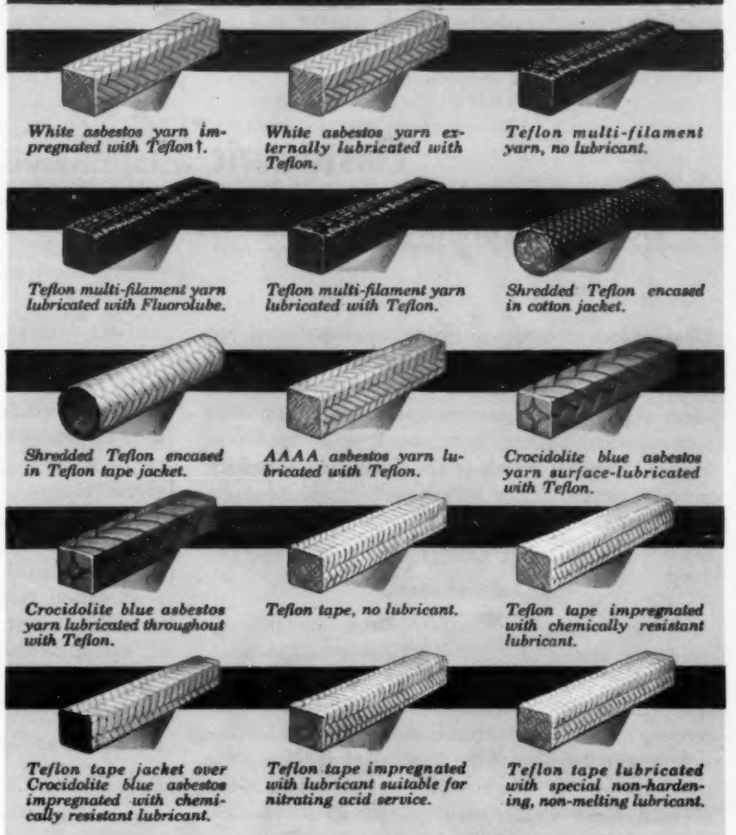
The comprehensive "Data on Titanium" alloys, beginning on page 65, is quite a departure from the usual approach in DESIGN NEWS. This is by far the largest reference article ever printed in DESIGN NEWS and represents several months of work on the part of New York Editor Vic Wigotsky and Associate Editor Bill Worth. It is also the most complete compilation of information on these relatively new alloys existing anywhere. Free reprints of this important article will be available through the Reader Service as long as they last.

Why have we stressed materials so much in one issue? It is our way to emphasize the importance of the right choice of materials in every design. Choosing the right material is basic. Most designs depend on the original choice of materials for the various components. If this issue stimulates some thought on the importance of materials in design, it will have served its purpose.

J. F. Dubois

Executive Editor

15 SPECIFIC PACKINGS FOR ALL CORROSIVE SERVICES



White asbestos yarn impregnated with Teflon†. — *White asbestos yarn externally lubricated with Teflon.* — *Teflon multi-filament yarn, no lubricant.*

Teflon multi-filament yarn lubricated with Fluorolube. — *Teflon multi-filament yarn lubricated with Teflon.* — *Shredded Teflon encased in cotton jacket.*

Shredded Teflon encased in Teflon tape jacket. — *AAAA asbestos yarn lubricated with Teflon.* — *Crocidolite blue asbestos yarn surface-lubricated with Teflon.*

Crocidolite blue asbestos yarn lubricated throughout with Teflon. — *Teflon tape, no lubricant.* — *Teflon tape impregnated with chemically resistant lubricant.*

Teflon tape jacket over Crocidolite blue asbestos impregnated with chemically resistant lubricant. — *Teflon tape impregnated with lubricant suitable for nitrating acid service.* — *Teflon tape lubricated with special non-hardening, non-melting lubricant.*

John Crane **CHEMLON** ***BRAIDED PACKINGS**

Specific service conditions are always best handled with a packing designed for the purpose. This is especially true when it comes to hard-to-handle liquids in pumps, valves, agitators, mixers, plating equipment and similar applications.

For this reason John Crane has developed 15 individual field-proved types of Chemlon Braided Packings. Within this line there is a type and style that will meet any combination of service conditions and requirements.

1. All known industrial acids, alkalis or solvents.
2. Temperatures from −120°F to +600°F.
3. High or low shaft speeds, also valve stems.
4. Longer packing life due to lower coefficient of friction and non-raveling construction.

Send in your service condition and we will recommend a Chemlon Braided Packing best suited to your application. Request Bulletin P-325.

Crane Packing Co., 6423 Oakton St., Morton Grove, Ill. (Chicago Suburb).
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

†T. M. for DuPont Teflon — **T. M. for the Best in DuPont Teflon*

CRANE PACKING COMPANY

Circle 4 on Reader-Service Card for more information

Elastomeric Suspension Systems for Shipping Containers

Flexible Suspensions Provide Handling and Shipping Protection against Shock and Vibration Damage

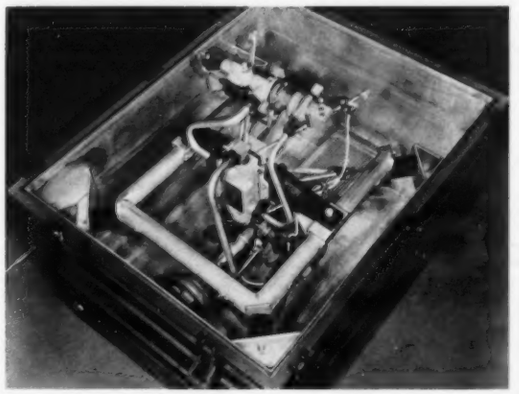
E. J. Stefanides, Central States Editor

Flexible suspensions in shipping containers are used for protecting a wide variety of products against damage during shipment. Employing elastomeric mountings, these suspensions provide protection against damage from shock and from prolonged vibration which might cause fatigue failure or malfunction. They also eliminate the need for over-design to achieve otherwise unnecessary ruggedness as a protection against failure during shipping.

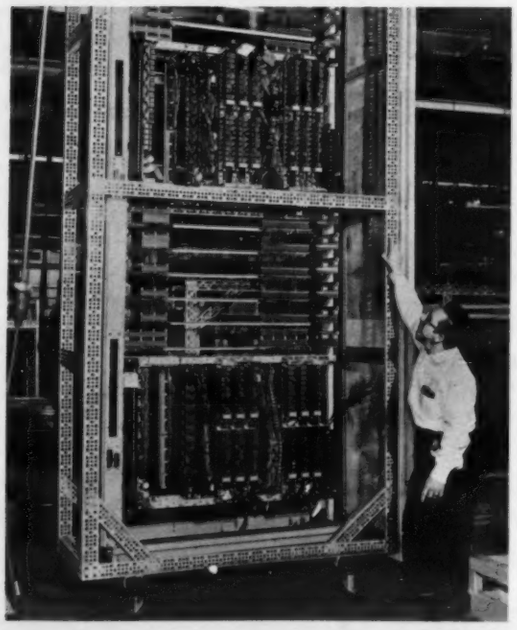
Design Criteria

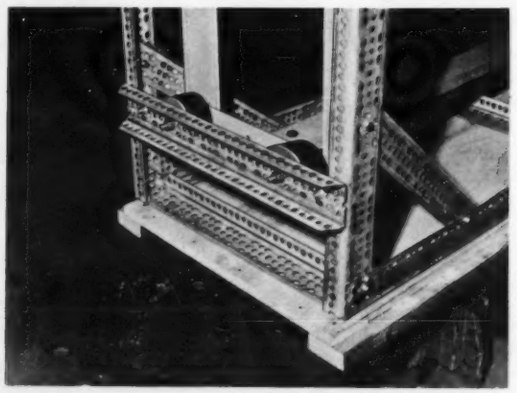
In the design of flexible shipping suspensions, shock protection in the vertical plane is generally the primary design consideration. Two factors determine how much protection is required in the system: the fragility of the equipment itself and the shock input. The fragility factor is expressed as the G load limit which the equipment can sustain without damage or malfunction. The fragility factor may be determined by one of three methods. In order of preference, these are: (1) destructive testing, (2) stress analysis and (3) estimates based on shipping experience. Determination of the fragility factor should include location of the fragile elements relative to center of gravity of the equipment.

Shock input is a definition of the maximum shock forces applied to the package during handling or transit. It is also expressed in terms of acceleration (G). Normally, shock inputs, resulting from accidental dropping or rough handling, are in excess of those induced by the jarring of the vehicle and are used to establish the shock input. For a suspension system with linear characteristics, the equation $d = \frac{2h}{G - 2}$ indicates the relationship between drop height (h) in inches, fragility factor (G) and deflection (d) in inches.



ROCKETDYNE VERNIER ENGINE is mounted on shipping frame supported by four elastomeric shear mountings attached to corners of aluminum shipping container. Corner mounting at 45 deg provides all-attitude protection during transit. (Container by Harvey Aluminum Co. for North American Aviation.)





ASSEMBLY OF SWITCHING EQUIPMENT begins with erection of slotted-steel framework of shipping container. Frame on which components are subsequently assembled is then flexibly suspended from shipping container frame by six elastomeric shear mountings. These provide multidirectional cushioning against vibration and handling shocks during all phases of production and shipping. Supporting structure and mounting are removed at destination and returned to manufacturer for reuse. (Kellogg Switchboard & Supply Co.)

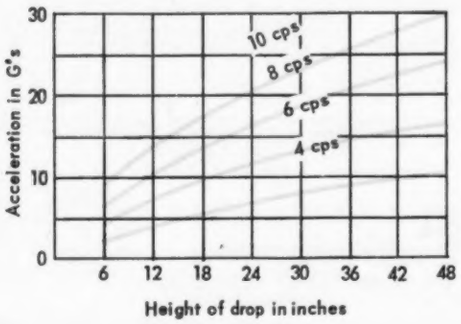
The limits for drop height and fragility factor should be based on realistic evaluation of shipping and handling conditions. Equipment normally carried at waist height can be protected against a 3-ft drop, which could result if the worker's hands slip, but cannot be economically protected against a 30-ft drop, as from a cargo net.

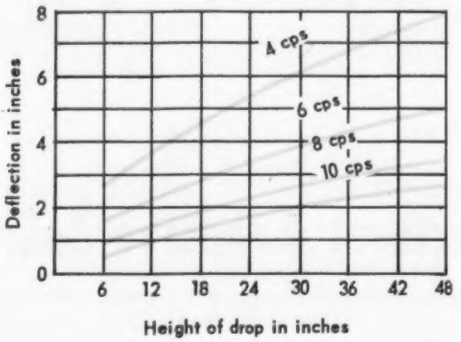
System Design

With the fragility factor (G) and drop height (h) established, the next step is to determine the required overall spring rate of the mountings (K) in pounds per inch and the deflection (d) of a suitable system. These are determined by using the following formulae:

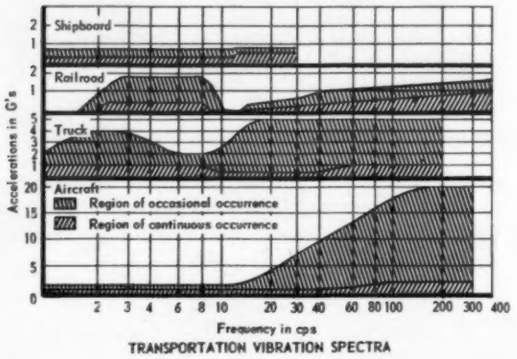
$$d = \frac{2h}{G - 2} \text{ and } K = \frac{2W\,(htd)}{d^2}\ ;\ \text{where}$$

(W) is the total weight of the equipment and its cradle in pounds. The value of (K) determined by this computation is the spring rate for the entire system. To find the spring rate (K) of the individual

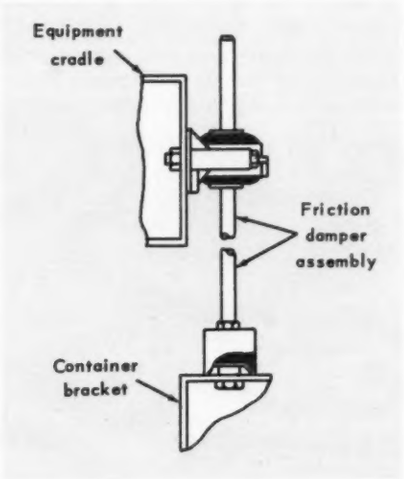


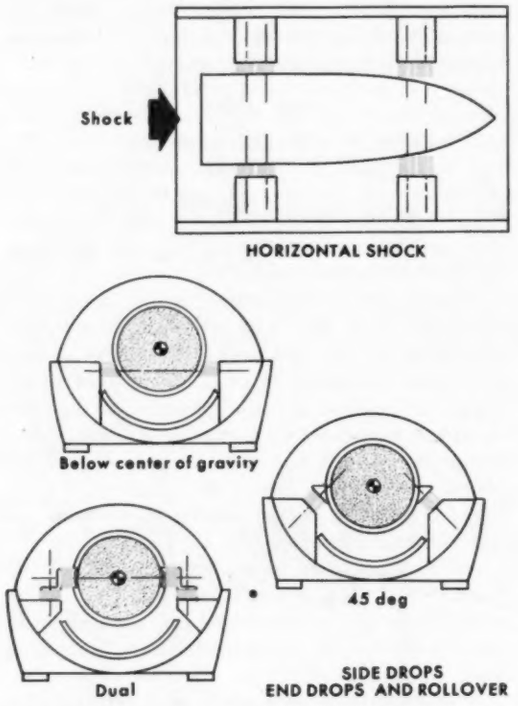


DESIGN CURVES show relationship of design factors in suspension system. Fragility factor (G) and deflection (d) are inversely proportional. As fragility factor is lowered, larger deflection must be provided. Deflection determines sway space that must be provided within container. Compatibility of shock and vibration requirements also can be determined from curves. If (G) limits place natural frequency (f_n) in critical 2 to 7 cps range, either stiffer suspension (higher G) or lower drop height (h) must be accepted or damping introduced.



INDIVIDUAL VIBRATION CHARACTERISTICS of various modes of transportation that must be considered in design of shipping suspension systems. Critical range in normal shipment is 2 to 7 cps. Test procedures generally should not include resonant dwell tests outside 2 to 7 cps range as inputs encountered above 7 cps are either too small or infrequent to be damaging.





MAXIMUM SHOCK PROTECTION in two shear modes of mounting, usually vertical and fore-and-aft, is provided by vertical arrangement. Mounting system for square and rectangular container also must be protected against flat drops on side. If compression spring rate mounting is too hard for adequate protection, mountings can be placed below center of gravity to deflect mounting in shear on side drop. Angular arrangement provides good vertical and lateral plus maximum fore-and-aft protection. Dual arrangement with two shear mountings at each point of attachment provides maximum all-attitude protection.

FRICTION DAMPER is used to control amplitude of flexible suspension systems operating at or near resonance.

mounting, the following step is required $k = \frac{K}{n}$; where (n) is the number of mountings employed.

Vibration Requirements

The system design which meets the shock requirements also must be compatible with vibration requirements. Common carriers have a prominent disturbing frequency in the range of 2 to 7 cps. In systems or equipment having a natural frequency above this range, resonant amplification is not likely to occur. Vertical natural frequency of a system can be calculated from the formula $f_n = \frac{1}{2\pi}\sqrt{\frac{K}{M}}$ where f_n is the natural frequency in cps and the mass $(M) = \frac{W}{g} = \frac{W}{386}$ in-lb-sec².

In some cases a soft suspension must be used because the equipment is very fragile. The natural frequency of such a system may fall within the critical 2 to 7 cps range. It then may be necessary to use special mounts with builtin damping or auxiliary friction dampers to control resonant amplification. Selection of the dampers will be dependent on the mounting used and vibratory input specified.

Other Shock Loads

Athough a suspension system is designed primarily to reduce shock in the vertical plane, consideration also must be given to the effects of horizontal shock loads. Normally, these will be equal to or less than the vertical loads. (However, the fragility factor may be less for horizontal shock loading.)

The effect of horizontal shock loads can generally be provided for in the arrangement of the mountings. Mountings installed with the shear axis vertical provide maximum shock protection in the vertical plane and along one horizontal axis. For square or rectangular boxes subject to roll-over, side and end drops, better lateral protection can be achieved by locating the mounts below the center of gravity, causing them to act in shear rather than compression. Even greater overall protection can be provided by installing two sizes of mountings in a gimbaled arrangement so that mountings are acting in shear along the three principal axes.

Environmental Conditions

Suitable protection against environmental conditions to which the mountings are exposed can be provided by proper selection of the elastomer. In most cases, natural rubber is satisfactory. Where resistance to oil and ozone is important, synthetic elastomers such as neoprene may be used. For extreme low temperatures, mountings are available whose performance remains constant within a broad temperature range from —65 to +165F.

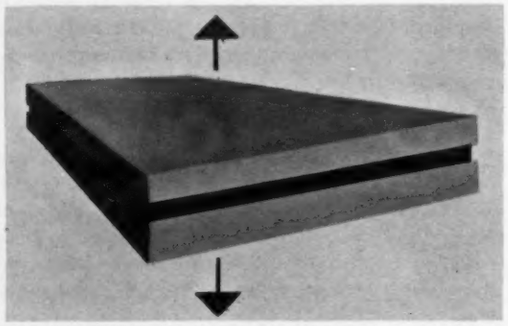
Technical information presented in this article was provided by the Lord Mfg. Co., Erie, Pa.

SPECIAL REPORT

Structural Adhesive Joint Design

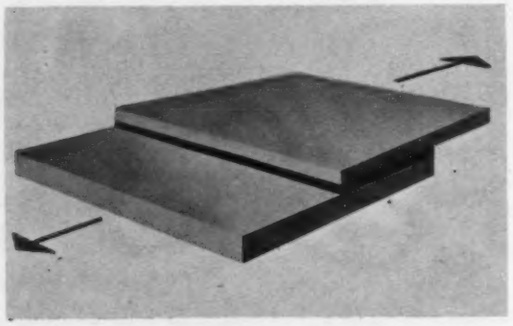
E. F. Hess, Product Manager, Adhesives, Coatings & Sealers Div., Minnesota Mining & Mfg. Co., St. Paul, Minn.

Like most design concepts, designing for structural adhesive bonding is largely a matter of common sense. However, two fundamentals should be kept in mind: (1) greatest strength is obtained if the maximum amount of bonded area (adhesive) is simultaneously put to work, and (2) geometry of the joint design should be favorable to maximum strength.



The four basic types of stress encountered in structural bonding are: tensile, shear, cleavage and peel. These stresses illustrate the first fundamental of joint design. It is advisable to design joints for tensile or preferably shear loading conditions and to minimize or eliminate cleavage or peel from the design configuration.

However, joint design is usually more complicated than indicated thus far. Rarely, if ever, will a joint be subjected to only one stress. In practice, there is usually a combination of several different types of stresses. In some cases, distortion of adherents under load will introduce secondary stresses. In these cases, the second fundamental of adhesive joint design dealing with the geometry of joints becomes important.



The following is a list of typical joints used in adhesive bonding. Their advantages and disadvantages illustrate the second fundamental pertaining to the configuration of joints as alternative for achieving maximum joint strength.

Lap Joints

In adhesive joint design, the shear or "lap" joint will be the most generally encountered. Most applications will involve thin gage metal, which is difficult to join by means other than lap joints. Secondly, lap joints are quite practical and applicable to adhesive bonding.

Because of the offset nature of lap joints, shear forces are not in line. This can result in the introduction of cleavage and peel stresses. In these cases the second fundamental of adhesive joint design should be applied and the geometry of the joint should be redesigned for maximum strength. Three design alternatives are open to increase performance.

(a) The joint can be redesigned to bring the load on the adherents in line.

(b) Adherents can be made more rigid near the bond area to minimize cleavage.

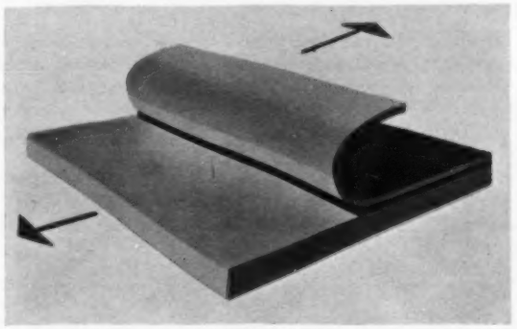
(c) Edges of the bond area can be made more flexible for better conformance, thus minimizing peel.

A beveled single lap joint is more efficient than a straight lap joint. The beveled edge allows bending of the joint edge when distortion occurs under stress.

The double-butt lap joint places the adhesive line in the same plane as the shear stress on the adherents. This type of joint, however, requires machining which is not always feasible with thin-gage metals.

Double-scarf lap joints have better resistance to bending forces than double-butt lap joints. This type of joint, however, also presents machining problems.

The joggle lap joint seems to be the most practical. It places the adhesive line in the same plane as the shear stress on the adherents. Application of pressure for curing is accomplished easily and the joint can be formed by simple metal-forming operations.

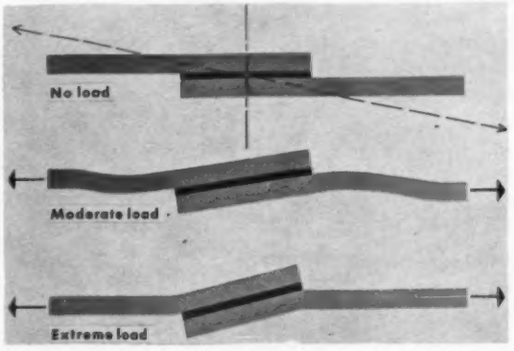


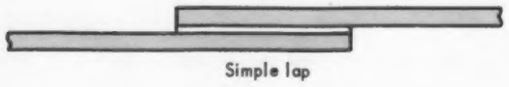
Butt Joints

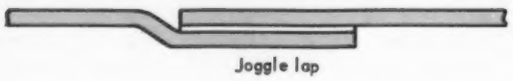
A straight butt joint is weak in cleavage. In the case where two flat metal rod ends are butt-joined with an adhesive, bending of the rods can, through leverage, exert tremendous cleavage forces on the joint.

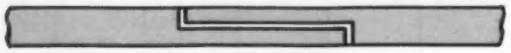
Recessed joints such as landed-scarf tongue and groove, conventional tongue and groove and scarf tongue and groove are recommended to avoid cleavage forces on joints through bending. However, joints must have adequate clearance to facilitate machining and assembling operations. Thus, adheisves with void-filling properties, such as epoxies, are required for butt joint assembly.

Landed-scarf tongue and groove joints have an advantage of acting as steps which could be utilized





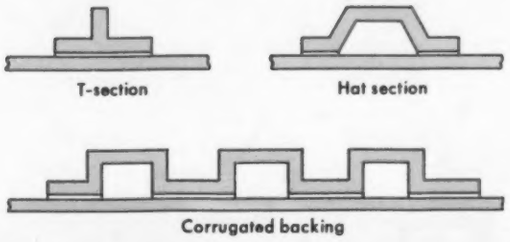




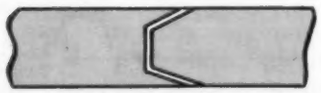
to control the adhesive line thickness. Scarf tongue and groove joints, on the other hand, make assembly easier, in that self-aligning takes place when tongue and groove are joined.

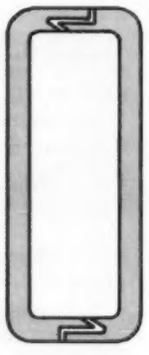
Stiffener Joints

When large areas of thin-gage metal are used, problems of "oil canning", waviness and flutter usually are encountered. Stiffening of such surfaces usually is desired and can be efficiently and economically accomplished by adhesive bonding stiffening members to the large sheet-metal areas. In the attachment of stiffening members to thin sheets, common in aircraft construction, the sheets deflect in service and peel stresses are exerted on the adhesives. If the flanges on the stiffening section can deflect with the sheet, minimum difficulty from peel will result. Either increasing the stiffness of the sheet or reducing the stiffness of the flange on the stiffening section will result in improvement.



Several types of stiffening members such as T-sections, hat sections and corrugated backing commonly are used. T-sections are simple. Hat sections are used more commonly and have excellent rigidity. Corrugated backing results in excellent flatness over the entire area.

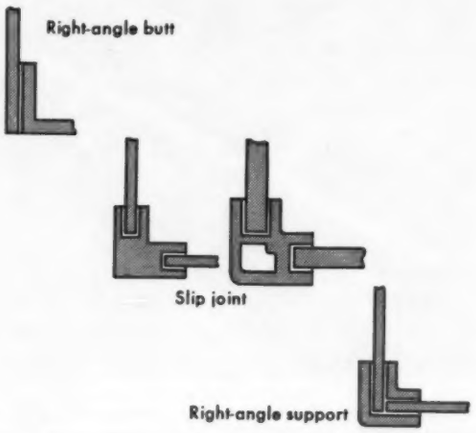




Typical adhesive-bonded butt-joint assembly

Corner Joints—Sheet Metal

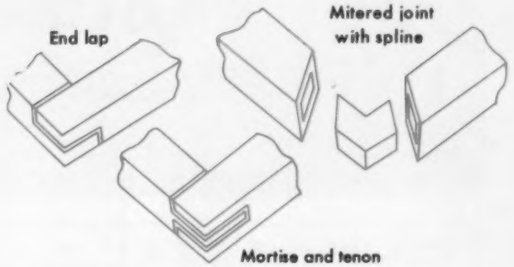
Adhesive bonding of corners of items made of light-gage sheet metal or sandwich panels can be accomplished with some joint redesign. The usual right-angle butt joint utilized for mechanical attaching is not applicable for adhesive bonding.



Sheet metal corner joints can produce either cleavage or peel stresses. The use of supplementary corner reinforcement attachments, however, permits adhesive bonding. The adhesive also seals the joint. Typical designs for adhesive bonding are slip joints and right-support angle joints. These joints also give the resultant structure an increased degree of rigidity.

In a slip joint, use of a supplementary corner extrusion is best. Extrusions can be as heavy as desired rigidity requires. The two edges of the part are bonded into the slip joint.

The use of interior and exterior right-angle supports is a variation from the slip joint. However, this method requires indexing fixtures until the adhesive is cured.



Film adhesives for these applications are not too desirable because of the complicated pressure fixtures required. Adhesives with void-filling properties such as epoxy types are indicated.

Corner Joints—Rigid Members

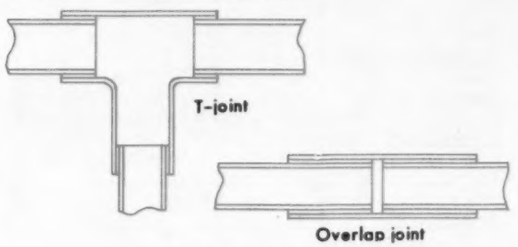
Corner joints, like those encountered when joining rigid members such as storm doors of decorative frames, also can be adhesive bonded. In these cases, butt joints would not be adequate for adhesives because of inherent racking or twisting stresess.

To make the required bond area resist such stresses, woodworking adhesive joint design, such as end lap, mortise and tenon, and mitered joint with spline, can be utilized.

End-lap joints are simple, but require machining. Adhesives requiring pressure could be utilized for this application. Mortise and tenon are excellent joint types but require machining. Mitered joint with spline should be considered if members are hollow extrusions. A spline is usually die cast to loosely fit interior of the extrusion. In this case, a void-filling adhesive also is indicated.

Cylindrical Slip Joints

The T joint and the overlap slip joint are recommended for bonding cylindrical parts. With adhesive bonding, all available contact area contributes to carrying the load. Adhesives also provide a joint with better appearance.

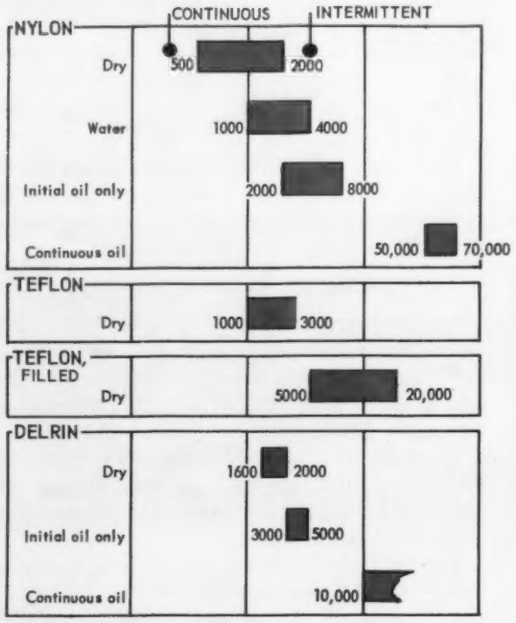


CYLINDRICAL SLIP JOINTS

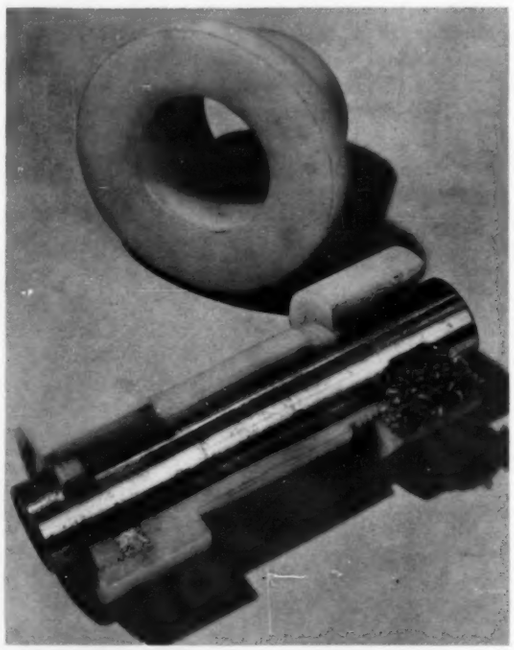
DESIGN SPECIAL REPORT NEWS

Design Criteria and Applications for Thermoplastic Bearings

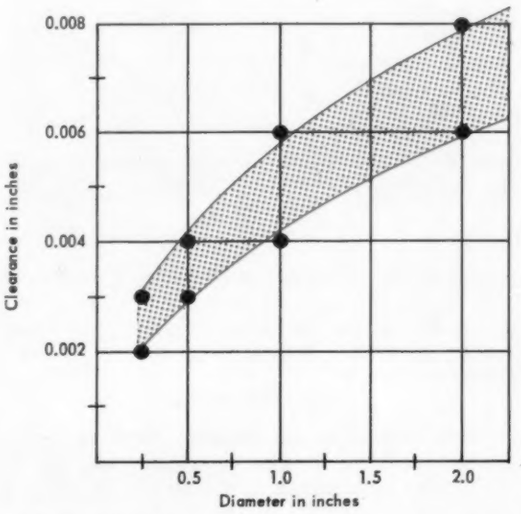
George C. Carlyon, V. P. Mfg., Cadillac Plastic & Chemical Co., Detroit, Mich., and
Albert Sniderman, Director, Sniderman Engineering, Detroit, Mich. (Now with Burroughs Corp., Detroit, Mich.)



MAXIMUM LOADS and speeds for plastic bearings may be determined by PV value, which is product of (P) surface pressure (load divided by bearing diameter times bearing length) and V (surface velocity of shaft in feet per minute). Recommended PV values for materials vary with method of lubrication. Physical testing of applications which exceed limits shown is recommended.



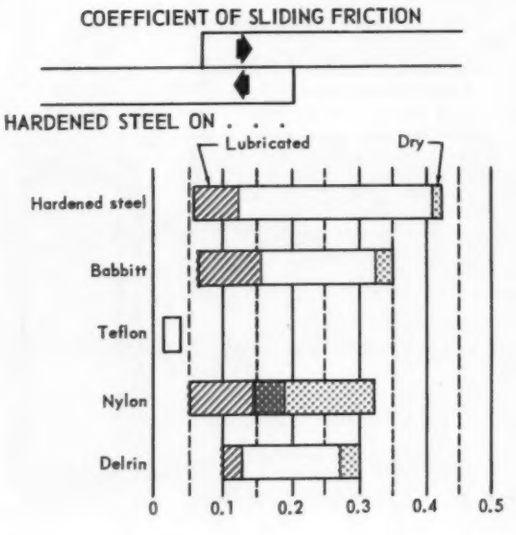
COMBINATION BEARING AND STUFFING BOX of molded nylon for boat propeller shaft. Installation is durable and low in cost.



CLEARANCES between shaft and bushings are slightly larger than normal practice with metal. Lower wear rate maintains average clearance over life of bearing. One part of assembly, usually shaft, should be metal to conduct heat from bearing area. This is imperative if bearing is to work near maximum PV value.

	TEFLON	NYLON	DELRIN
STRONG ACIDS	Good	?	Poor
WEAK ACIDS	Good	Fair	?
ORGANIC SOLVENTS	Good	Good	Good
WEAK BASES	Good	Good	?
STRONG BASES	Good	?	Poor

♦ **NYLON** is attacked by concentrated acids but has good resistance to most other reagents. Delrin should be tested for use with diluted acids or alkalies. Teflon is not affected by any chemical likely to be encountered in normal experience.



It has been only in the last five years that plastics have had widespread use in bearing applications. At present, most research is conducted on nylon, "Teflon" and "Delrin", although several other plastics, including the polypropylenes and high-density polyethylenes, eventually may be added to the list, especially for low load and speed applications.

Plastics are best suited where the following common problems are encountered:

1. Lubrication is neglected or functionally impossible.
2. Abrasives or corrosives are present.
3. Stick-slip phenomena impede operation.
4. Noise levels are high.
5. Electrical conductivity presents hazards.

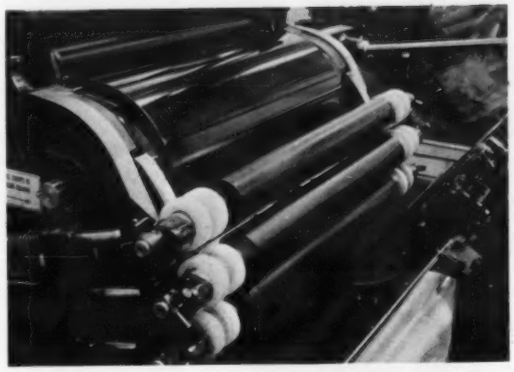
Advantages of plastics, particularly nylon, Teflon and Delrin, in these applications are:

1. Low coefficient of friction, in some cases permitting them to operate dry or with initial lubrication only. Dry Teflon has lower coefficient of friction than any other bearing material lubricated in oil.
2. High embedability and abrasion resistance. Nylon has approximately 10 times the abrasion resistance of mild steel. Nylon and Teflon also have the property of absorbing abrasive particles from the environment, embedding them harmlessly in the plastic.
3. No slip-stick, that is, equal static and dynamic coefficients of friction. (This is true only of Teflon and Delrin.)
4. Vibration damping properties. This is particularly true of nylon.
5. Chemical resistance ranging from extraordinary in the case of Teflon to fair in case of Delrin.

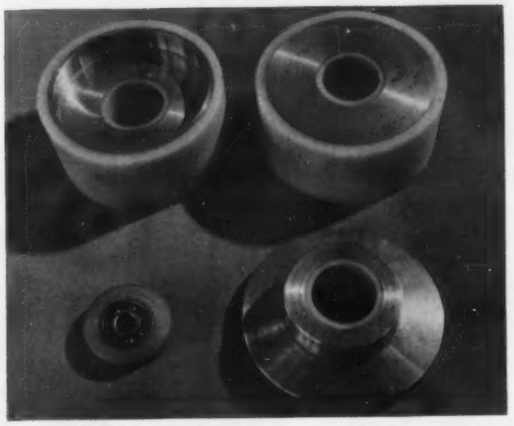
Plastics are poor conductors of heat and also have much higher thermal expansion rates than metals. Therefore, in designing plastic bearings, consideration must be given to efficient heat dissipation. One approach is to use the plastic as a thin liner in a metal sleeve which carries off the heat. Another is to lubricate with water, not for its lubricating value but for its conduction of heat.

Creep or cold flow only becomes critical when unit load is high. Plastics tend to deform much more than metals, but the rate decreases with time and after a certain point is negligible. For practical design purposes, the deformation at less than 1 percent strain after a one-year period reaches a magnitude about equal to that of the initial strain. To estimate total deformation, the initial strain may be multiplied by two.

Serious consideration must be given to the design of any particular bearing. Since the field of plastic bearing design is still comparatively new, it is advisable to physically test any particular design before production.



NYLON GUIDE ROLLS on printing press operate without lubricant, eliminate possibility of contaminating ink.



ROLLERS on electroplating machine mechanism have Teflon plastic outer tire and plastic bearing insert. Noncorrosive bearings operate without lubricant.

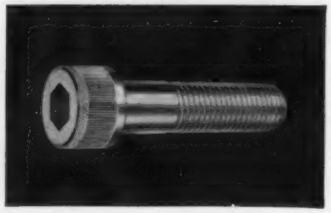
PHYSICAL PROPERTIES OF BEARING PLASTICS

	NYLON	TEFLON	DELRIN
Fatigue endurance limit (psi)	3000	1000	3000–5000
Yield point at 73F (psi)	8500	850–1800*	10,000
Compressive stress at 1 percent strain at 73F (psi)	2000	100–200*	5200
Modulus of elasticity in compression at 73F	200,000	70,000	380,000
Maximum continuous service temperature (deg F)	150	500	180
Heat distortion temperature 66 psi (deg F)	345–360	250	338
Coefficient of thermal conductivity, Btu per inch per hr per ft^2 per deg F	1.7	1.7	1.6
Coefficient of linear thermal expansion, inch per inch per deg F	(4.6) to (5.0) (10^{-5})	(6.9) (10^{-5}) (77–212F) (11.1) (10^{-5}) (32–77F)	(5.5) (10^{-5})

* Filled compositions

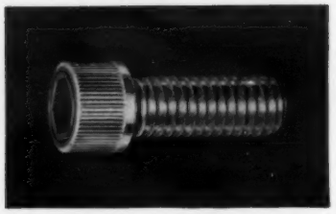
Here's what **UNBRAKO**—and only **UNBRAKO**—now offers you in **standard** socket head cap screws

UNBRAKO pHd Hi-Life, today's only all-new socket screw. Increased bearing area, radiused thread root give up to 2⅓ times as much holding power, twice the fatigue strength of ordinary screws.



K 16 socket heads give you a bonus of 300% more fatigue life than regular socket screws; replace costly specials, provide design insurance in high fatigue applications.

Stainless UNBRAKOS meet your needs for corrosion-resistant fastening through a temperature range from −300° to 800°F. Other design considerations: low magnetic permeability; good appearance.



UNBRAKO KS 812 stainless socket screws offer 125,000 psi tensile—*certified;* help you increase strength of stainless assemblies without paying the price of specials. Identified by groove around socket.

Lately you have been reading about new developments in the design and performance of UNBRAKO socket head cap screws. For your reference, here is the complete story in one package:

UNBRAKO pHd* with Hi-Life Thread
The advanced tension fastener for the '60s. New pHd head with increased bearing area gives you up to 2⅓ times as much holding power, safeguards preload, defies loosening under vibration. Radiused root of new SPS Hi-Life thread form drastically redutes stress concentrations at point where 85% of screw failures occur. Result: Twice the fatigue life. Forged heads, rolled threads preserve grain flow, add further strength and fatigue resistance. Available with Nylok† self-locking feature if desired. Sizes #0 to 1½ in. in alloy steel . . . full range of plating and other finishes. Tensile strength: 160-200,000 psi.

Stainless UNBRAKO Socket Screws
Available in a variety of corrosion-resistant alloys . . . and with Nylok. Standard processing includes passivation surface treatment, which forms a protective film and removes contaminants. Silver plating and/or molybdenum disulfide can be added as a lubricant to prevent galling and reduce the thread friction sometimes encountered at elevated temperatures. Sizes #0 to ⅜ in. with forged pHd head and fully formed Hi-Life thread.

NEW HIGH-PERFORMANCE UNBRAKO K SERIES

UNBRAKO K 16—Endurance fasteners replace specials in high fatigue service. They give you *twice* the fatigue life of regular UNBRAKOS; *four* times that of ordinary socket heads—in a *standard* fastener, reasonably priced. Threads rolled, fillet under head cold worked—both after heat treat. Shank precision ground to insure no decarburization. Sizes #8 to ½ in. in 8740 A.Q. steel. pHd head, Hi-Life thread.

UNBRAKO KS 812—A stainless socket head cap offering a guaranteed tensile strength of 125,000 psi *minimum.* Yet this precision forged, burr-free fastener is a standard, available in quantity off the shelf. Made of high-grade austenitic stainless, hardened through cold working. Has pHd head for greater holding power; SPS Hi-Life thread for increased fatigue resistance. Magnetic permeability under 1.2. Serviceable from −300° to 800°F. Sizes #8 through ⅜ in.

Standard UNBRAKO socket head cap screws are available from stock through your industrial distributor. See him for more information or write Standard Pressed Steel Co. INDUSTRIAL FASTENER Division, SPS, JENKINTOWN 6, PENNSYLVANIA.

*proper Head design (1960 Series)
†T.M. Reg. U.S. Pat. Off., The Nylok Corporation

SPS

where reliability replaces probability

Circle 5 on Reader-Service Card for more information

SEEN AND HEARD

E. J. Stefanides, Central States Editor

"This", said Mr. Ford pointing to the artist's sketch on the blackboard, "is the Materials Application Center, the educational focal point of this year's Metal Show. Here the visitor will be able to study and examine at first hand scores of products, each representing an outstanding materials application. Some of these applications have been chosen because of their exceptional service performance, others because of their adaptability to economical fabricating techniques, but all of them should be of interest to the designer."

1961 METAL SHOW

We were discussing the 1961 Metal Show to be held in Cobo Hall in Detroit, October 23-27. A. P. Ford is Director of Communication of The American Society for Metals, sponsors of the show. He was explaining the central theme of this year's show, The Materials Application Center.

"Don't let the futuristic appearance deceive you," he continued. "This is probably one of the most functional educational exhibits ever designed for a major trade show. For the first time at any show, the visitor will be able to successively examine and evaluate a wide range of materials for a variety of specific application requirements."

Slightly puzzled, I interrupted him to ask for a slightly more detailed explanation.

"Well," Mr. Ford explained, "it's very simple. The displays are housed in seven pavilions arranged much like the spokes of a wheel. Each pavilion contains products of a single material group and each is arranged in eight concentric zones of similar property categories. Thus, a visitor traveling around the pavilion in a given property zone might successively examine applications of cast and wrought steels, cast and wrought nonferrous metals, stainless and heat resistant alloys, and even high-strength nonmetallics. Or, if he is interested in high temperature characteristics, fatigue or any of the other property categories, he can see appropriate applications or specimens of the same materials in these categories."

This sounded like quite a departure in theme from The Metal Shows of previous years, and I was curious as to the reasons behind this change in thinking, this emphasis on materials applications.

THE MATERIALS PROBLEM

In answer to my question, Mr. Ford replied, "We of The American Society for Metals have become increasingly aware of the importance of the materials problem. Materials and their technology are practically the only weapons available to the American manufacturer in defense of his competitive position. Thus, the selection of the material may well be the most important decision the designer makes in creating his design. Therefore, it is imperative that he and others responsible for material selection be aware of the latest developments in materials, fabrication techniques and the allied processes. The big problem lies in the speedy *application* of this increasing technology, the rapid dissemination of this wealth of technical information. This is our objective—to speed the communication of this information by showing actual application of this technology in product design. In setting up the center we have in effect created a three-dimensional catalog of materials application, where the visitor may study the significance of these developments at first hand."

SHORT COURSE IN MATERIALS TECHNOLOGY

"Sort of a short course in engineering materials and materials processing", I remarked.

"Exactly," he replied. "The center, the papers and the other exhibits will provide a short, intensive training course for people who must keep abreast of new developments in these fields and must apply these new concepts in product design and production."

He then went on to explain how the other features of the show would supplement this accent on *time* and *technology*: how the more than 200 timely technical papers would help to bridge the all-important "time lag" between conception of an idea and production of the finished product; between development of a new material or process and its practical application.

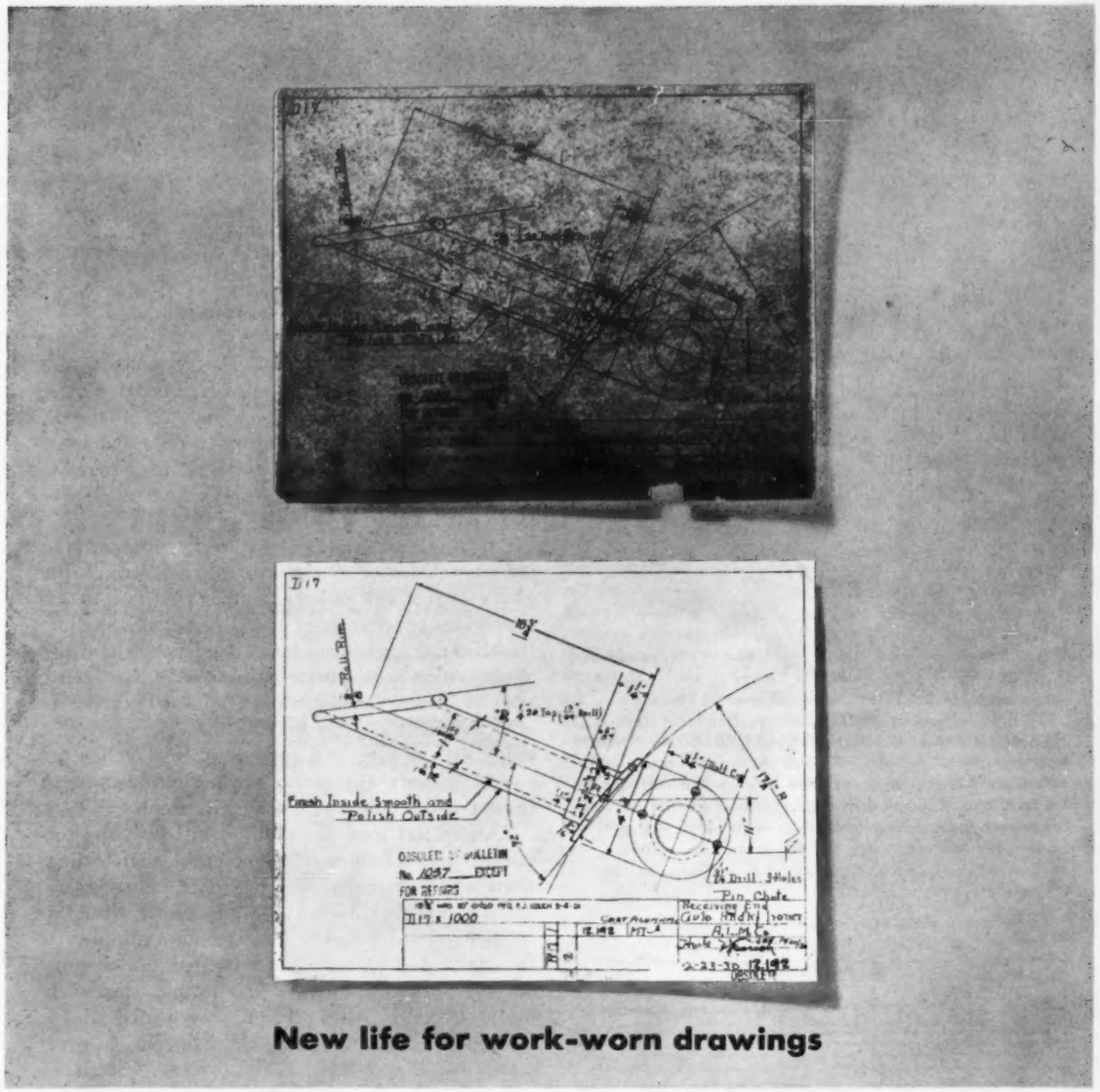
He also called attention to the 250 exhibitors. He explained how the exhibitors had been strictly screened to attain the highest concentration of educational exhibits pertinent to the subject, and to eliminate those which were inappropriate.

FUTURE TRENDS

Before leaving I had one last question. Would this materials application theme be continued in future Metal Shows?

His reply, "Yes, we feel this will become a permanent educational function of the society and a permanent feature of the annual show. The pressures of improved product performance and decreased fabrication costs have engendered a trend toward development of materials whose properties are more closely tailored to their ultimate application. This trend will result in development of more specialty products even in such areas as steel. These products, which will be more closely fitted to the designers' needs, will eliminate many fabrication and processing steps. Their use will result in more efficient designs which better meet the performance requirements, and at minimum fabrication expense. There will be an increasing need for rapid communication of information concerning these developments to the people responsible for the design and production of new products. The American Society for Metals feels that the application center will be an important factor in fulfilling this need."

I agree. This year's Metal Show offers an excellent opportunity for the designer to take direct action in improving his own orientation in the complex modern materials technology.



New life for work-worn drawings

. . . at a fraction of the usual redrawing time and cost! Now you can transform tired-out, tattered originals into crisp, legible drawings again. You can do it quickly and easily, too, without costly, tedious redrafting—simply by making "second originals" on Du Pont CRONAFLEX® Direct Positive Film!

Drawings wrinkled and dog-eared from repeated handling . . . yellowed and dirty with age? CRONAFLEX makes them like new again, adding the extra benefit of durability! And you can do the whole job in a single, easy step because CRONAFLEX Direct Positive Film requires no negative! Modifications can be made at any time, thanks to its excellent drafting surface.

Direct Positive is just one of Du Pont's complete line of CRONAFLEX Engineering Reproduction and Drafting Films. To learn more about these products and how they can make your operation more efficient, clip and mail the coupon today.

DU PONT

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

E. I. du Pont de Nemours & Co. (Inc.)
Photo Products Department DN 9
Wilmington 98, Delaware
In Canada: Du Pont of Canada, Ltd., Toronto

Please send me, with no obligation, complete technical data on CRONAFLEX Direct Positive Film plus detailed information on the entire CRONAFLEX line.

Name _____

Firm _____

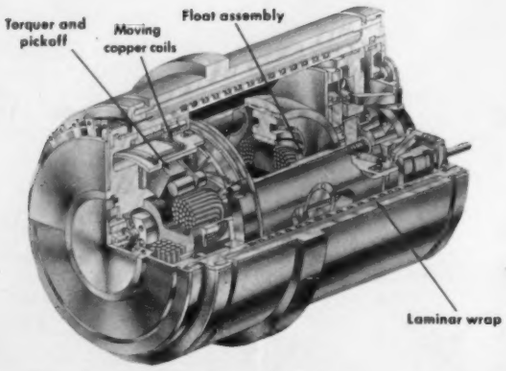
Address _____

City _____ Zone _____ State _____

Circle 6 on Reader-Service Card for more information

'Matched' Materials and Moving Copper Conductors Improve Gyro Precision

Victor W. Wigotsky, Eastern Editor



HERMETICALLY SEALED MINIATURE GYRO features long-term drift stability. Typical day-to-day repeatability values are 0.2 deg/hr/G for mass balance and 0.04 deg/hr for fixed bias. Random drift cogging tests of inertial guidance component indicate standard deviation of 0.007 deg per hr in azimuth and 0.005 deg per hr in vertical positions.

Selection of materials for uniform thermal response increases the precision of a miniature floating gyro. Overall design reflects stringent analysis of material, matching requirements to assure thermal and stress symmetry over the entire operating range. Precise material selection is evident as a vital aspect of every part of the gyro's design.

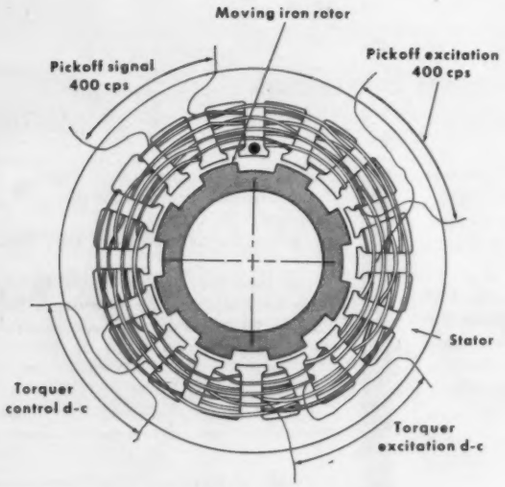
Choice of material also figures significantly in the elimination of spurious reaction torques in the gyro's torquer and pickoff. Moving copper coils are used in an application of the D'Arsonval principle. Disadvantages resulting from the conventional use of a rotating iron element, connected to the float, are eliminated. Instead, a glass-bonded mica sleeve, now mounted on one end of the float assembly, holds the torquer and pickoff coils. The copper conductors are the only moving elements with respect to the stationary magnetic fields.

This differs from the method in which the torquer or pickoff rotor is composed of iron laminations which rotate according to the flux differential induced by excitation and control windings. Uniformity of the iron material and contours is then critical in order to prevent generation of spurious reaction torques. The new torquer and pickoff assembly is a simple air core device which, through the use of the moving copper coils, overcomes these problems. Thus, careful analysis of material characteristics, in relation to design, eliminates necessity for precise electrical centering or extremely close tolerance machining to avoid reaction torques.

The thermal design of the floated gyro is an essential element in its accuracy. Exact flotation must be maintained under all operating and environmental conditions. Conductivity of the thermal insulation must be high enough so that the gyro will dissipate internally generated heat, and yet small enough to limit power required for floatation at low ambients. In addition, magnitude of temperature gradients existing in the damping gap must be limited sharply. These error-producing temperature gradients result from causes both internal and external to the gyro.

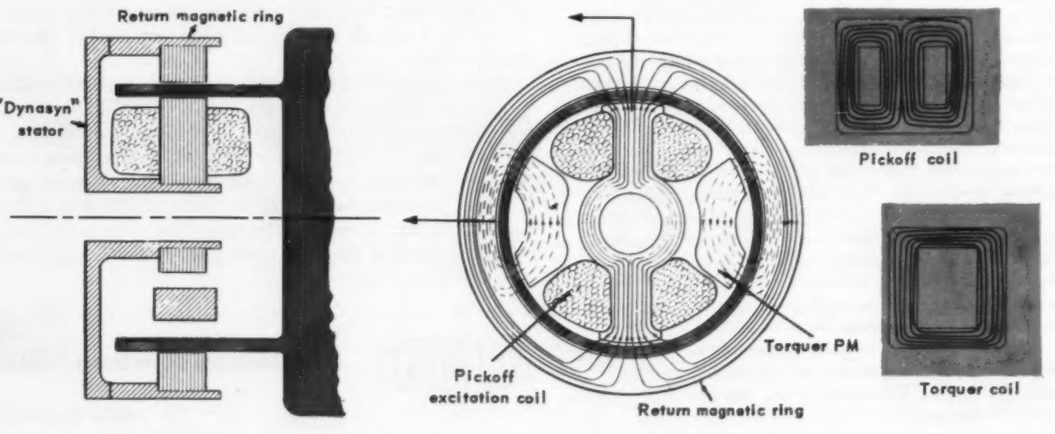
Thermal drifts caused by internal temperature differences are prevented by matched materials and symmetrical conduction paths and heat sources within float, torquer and pickoff. Heat conduction within the float is diverted through gimbal beams to the end plates. In addition, the symmetry of the gyro rotor promotes gas temperature uniformity through a rotor-induced turbulence. This in turn reduces cylindrical float wall temperature asymmetries, since the wall is structurally isolated from the internal heat sources,

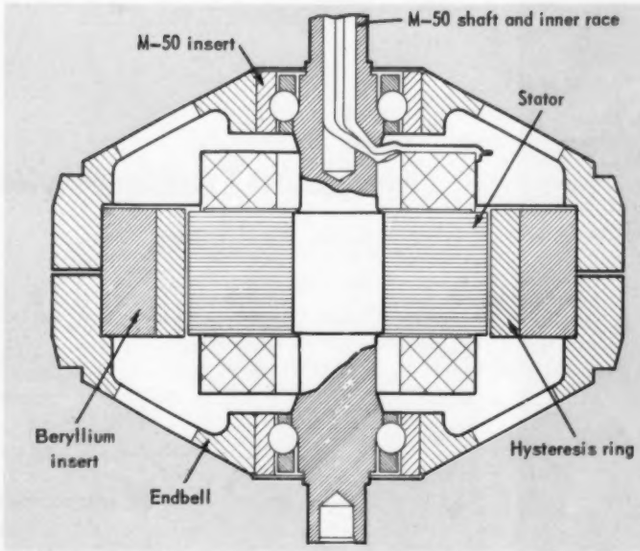
The SYG-1000 miniature integrating floated gyro, with the "Dynasyn" torquer and pickoff, was designed by Sperry Gyroscope Co., Great Neck, N. Y. ("Dynasyn" is a registered trademark of Sperry Rand Corp.)

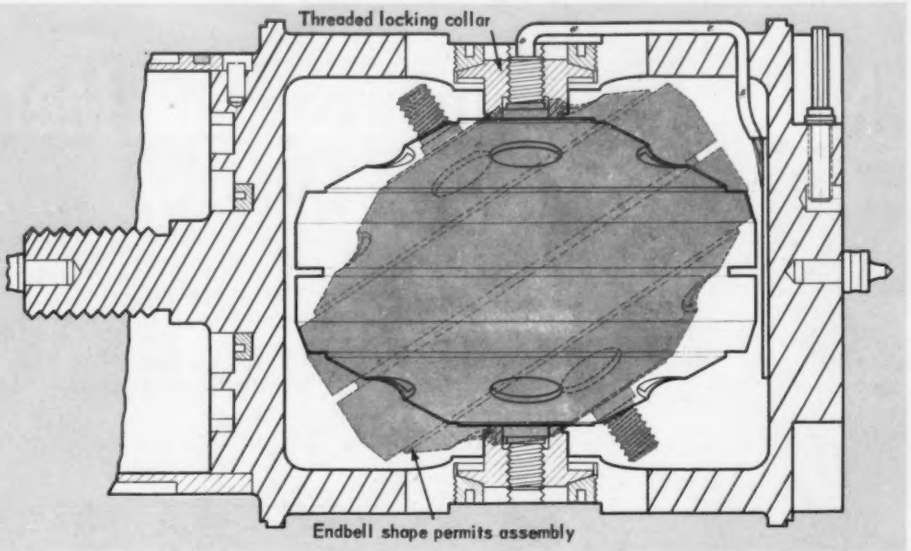


CONVENTIONAL TORQUER PICKOFF

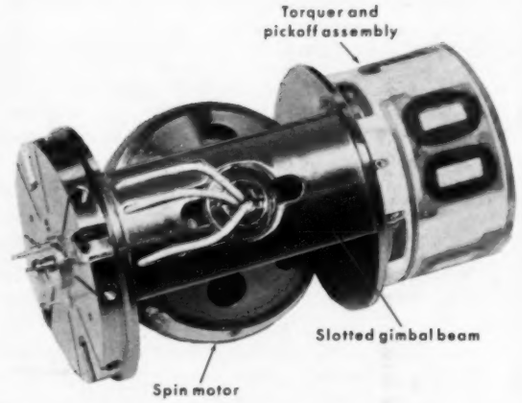
CONVENTIONAL TORQUER AND PICKOFF has rotor composed of iron laminations. Rotor operates in proportion to flux differential induced by excitation and control windings. Spurious reaction torques occur if composition and contours of moving iron rotor are not precisely uniform.



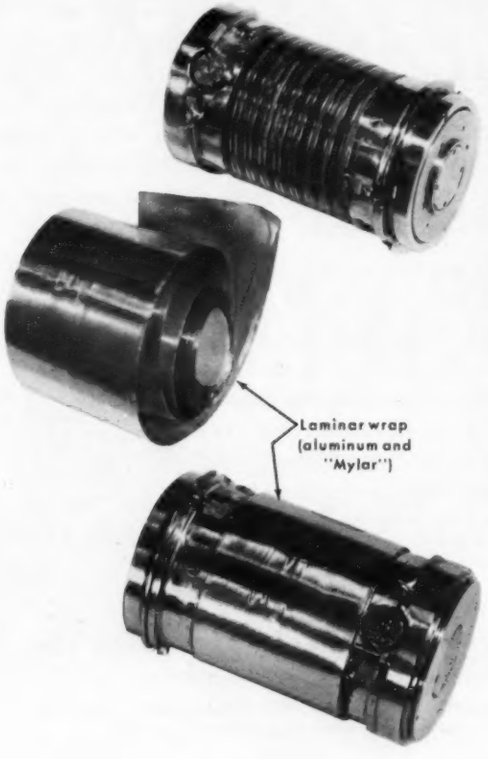


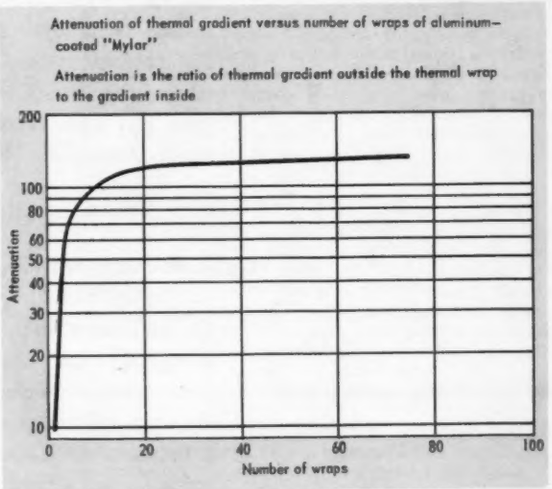


MATERIAL SELECTION in gyro wheel and gimbal design emphasizes structural and thermal symmetry. Assembly provides improved bearing life and structural compliance control. Materials are matched to provide uniform stress and thermal characteristics over entire operating range. Stator generates rotating field, causing wheel rotation at 24,000 rpm. Expansion coefficient of nonmagnetic beryllium insert matches hysteresis ring and bearing steel of endbell. Symmetrical rotor assembly has M50 tool steel shaft and balls. Rotor is 52100 steel and contains M50 bearing race insert. Inner bearing races are machined directly on shaft and outer bearing races are machined on inserts. Integral construction and similar thermal expansion coefficients of all structural parts assure constant bearing preload. Threaded locking collars fasten spin motor shaft into horizontally slotted gimbal beams. Previously, it was necessary to notch gimbal beam and then use pillow blocks to assemble wheel. This resulted in comparatively weak beam with unequal stiffness because of machined notches. New locking arrangement is less stress-inducing along critical planes.



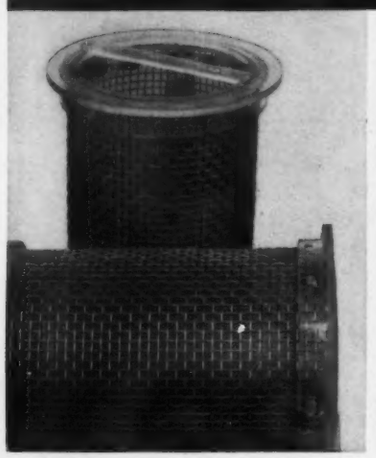
MOVING COPPER COILS avoid spurious reaction torques. New torquer and pickoff consists of three concentric members. Inner, stationary assembly holds continuously energized a-c input windings for pickoff and two magnets. Latter furnish flux for torquer operation. Intermediate rotary sleeve, attached to gyro float, contains pickoff output windings and torquer input windings. Outer, stationary lamination assembly forms return path for magnetic circuits of both pickoff and torquer. Flux paths are always stationary with respect to laminated structure. As gyro rotates about its output axis, pickoff output winding rotates with respect to a-c field and develops output voltage. Similarly, torque is developed when torquer input winding is energized with direct-current command signal. Torque is linear with current to better than 0.01 percent and torque sensitivity is independent of gyro float angle for several degrees of rotation. Nonmagnetic sleeve member which carries windings is attached to float. Thus, only conductors move with respect to stationary magnetic fields.



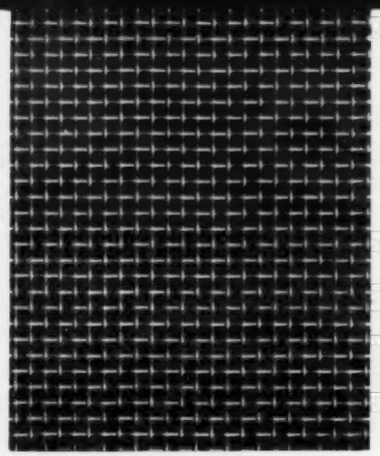


LAMINAR WRAP—alternate multilayer wrap of conductor (aluminum) and insulator ("Mylar")—provides high degree of temperature-gradient attenuation. This permits dissipation of internally generated heat and provides required thermal insulation, as well as attenuating effects of external temperature disturbances. Damping gap is then essentially isothermal in circumferential direction. In addition to diminishing thermal gradients, laminar wrap provides greatly improved attenuation to periodic thermal transients.

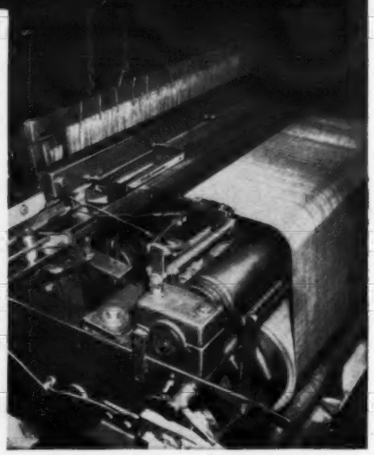
Need Wire Cloth in Special Metals? call *Cambridge*



HASTELLOY C*



SILVER



TITANIUM

Working with unusual metals or alloys—as well as with standard metals and alloys—is almost an everyday occurrence at Cambridge. For instance, not too long ago, we developed the first practical method of weaving titanium into wire cloth—with mesh counts far higher than had been expected by the customer. Platinum, lead, stainless steel, or bronze—whatever the metal or alloy used, Cambridge has the experience and facilities to produce wire cloth in any size or quantities to the closest tolerances.

If you require fabrications—of any shape or size—Cambridge has the craftsmen and know-how to fill even the most rigid specifications. Or, we'll draw up prints for your approval. There's a wire cloth expert near you—ready to discuss your needs and show you how to get what you want economically and on time. He's your Cambridge Field Engineer... and his name is listed in the Yellow Pages under "Wire Cloth." Or, write for our illustrated, 120-page catalog.

Refer to our technical data sheets in CHEMICAL ENGINEERING CATALOG, Page 185

The Cambridge Wire Cloth Co.

DEPARTMENT D • CAMBRIDGE 9, MARYLAND

Manufacturers of Wire Cloth, Wire Cloth Fabrications, Metal-Mesh Conveyor Belts and Gripper® Metal-Mesh Slings.

*Reg. T.M. of Union Carbide Co.

Circle 7 on Reader-Service Card for more information

Magnesium Extrusion Provides

E. J. Stefanides, Central States Editor

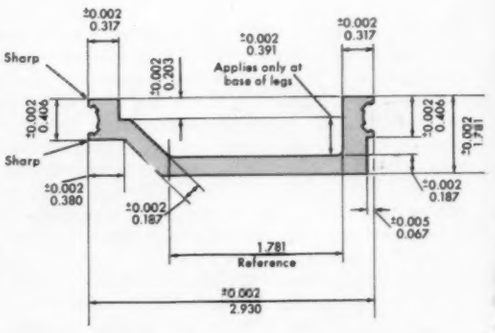
A precision magnesium extrusion is used for the carriage base of a new office electric typewriter. Extrusion achieves a close-tolerance part at relatively low cost. Low weight permits a wider carriage design having greater stability but without loss of carriage speed.

Design of the typewriter called for a bridge-type carriage with hardened-steel ball inserts. In order to achieve greater stability, inserts were placed on 3-inch centers. This is wider than in competitive machines. Ordinarily, the increased stability resulting from the wider design would have been offset by a loss of carriage speed because of increased carriage weight.

The problem was solved by switching to a carriage base manufactured from magnesium and produced by a precision extruding technique. The extruding process allows the base to be used without subsequent profile machining.

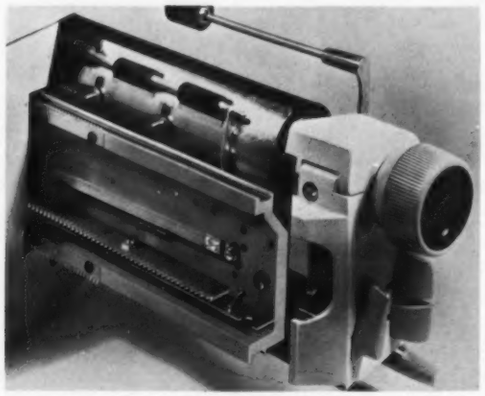
A combination of the extrusion process and special finishing operations allows cross-sectional tolerances as close as ±0.001 inch to be maintained. The distance between ball centers varies less than 0.001 inch along the length of the carriage.

Durability of the magnesium shape has been laboratory tested by mounting a 16-lb weight on a carriage subject to cycling. After 1.5 million cycles there was no measurable wear or indentation of the raceways, indicating no distortion of the extrusion.



CARRIAGE BASE showing 12 cross-sectional dimensions on which precise tolerances of ±0.002 inch are maintained. Precision extruding process allows tolerances as close as ±0.001 inch. With conventional extrusions, tolerances would not be closer than ±0.006 inch.

Stability without Loss of Speed

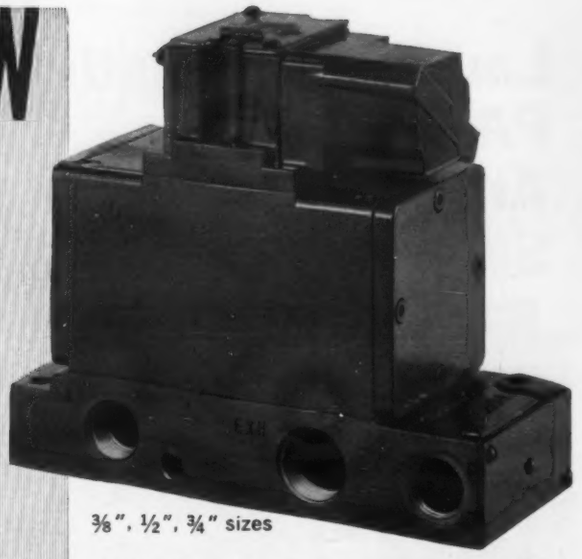


UNDERSIDE of typewriter shows relation of magnesium carriage base to other components. Carriage end cover has been cut away to expose carriage base configuration. Ball race inserts are at top and bottom of carriage base.

CARRIAGE with roller removed to show carriage base. Same extruded profile is used for all model sizes from 13- to 27-inch carriage length. Extrusions are cut to length at mill. Only operation required by manufacturer is drilling of series of holes for mounting of other components.

The carriage is used on the Smith-Corona "400" Typewriter, designed and manufactured by the Smith-Corona Div. of Smith-Corona Marchant, Inc., New York. The magnesium extrusions are produced by the Dow Metal Products Co., Midland, Mich., a division of the Dow Chemical Co.

NEW HANNIFIN "HUSTLER" VALVES GIVE YOU SPEED, SURENESS & GOOD SERVICE



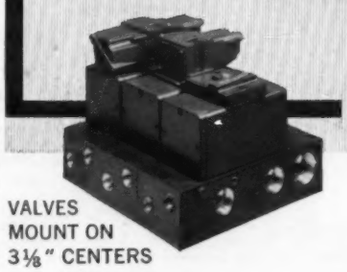
3/8", 1/2", 3/4" sizes

ALL the features you want in 4-way, pilot-operated air control

HOW FAST? So fast it fills 12 cu. in. test chambers from 0 to 90 psi in 0.029 seconds. Larger, 100 cu. in. chambers fill in 0.075 seconds. Valve itself has been cycled on test over 3,000 times a minute. We know of no faster valve.

HOW SURE? Valve will operate on severely restricted air supplies and at pressures down to 15 psi, thanks to a reserve volume of pilot air, maintained at maximum line pressure in a self-restoring accumulator chamber (patent applied for). Low-wattage, nylon encapsulated, plug-in solenoids are guaranteed for life against burnout. New "Comb-O-Seals"—one-piece, pressure-energized—seal positively, cannot be improperly assembled. Any of today's varied air line lubricants can be used. Both pilot valve and main valves operate on poppet principle, cannot stick in dirty air.

HOW GOOD? Good for millions of leak-proof cycles! All-aluminum, die cast construction gives you light weight, assures clean, smooth air passages. Base mounting—all connections, air and electrical, are permanently made to the base. Quick plug-in feature —entire operating unit "plugs" into base; remove two screws and it lifts off easily and quickly. Locking manual over-ride is standard on all solenoid models. All models fully meet J.I.C. standards.



VALVES MOUNT ON 3 1/8" CENTERS

ADD-A-FOLD BASES (optional) permit joining a number of valves together, with one supply, one exhaust, one gallery for electrical connections.

You can have either maintained or momentary contact electrical actuation—or remote pressure actuation. Valve is available in 3/8", 1/2" and 3/4" pipe sizes. Write for new Bulletin 0611-B1.

PARKER-HANNIFIN

HANNIFIN COMPANY DIVISION

535 South Wolf Road • Des Plaines, Illinois

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS

3419-PH

Circle 8 on Reader-Service Card for more information

Laminated Plastic PARTS Any Size. Simple or Complex

An Example of
Synthane *You-shaped* Versatility

No matter how many laminated plastics parts you need, Synthane Corporation is the place to buy them. We're versatilely equipped to do the job—with hundreds of machines, designed especially for handling laminated plastics. Our people have years of experience in tackling any job in quantities from one to a million, in sizes large, small or in between, simple or complicated. This specialization results in complete control from manufacture of material to finished parts.

You-shaped Versatility makes Synthane a Better Buy in Laminates

SYNTHANE CORPORATION OAKS, PENNA.

Synthane Corporation, 6 River Road, Oaks, Pa.
Gentlemen:
Please send me information relating to Synthane as a source for laminated plastics materials and parts.

Name_____

Address_____

City_____ Zone____ State_____

Circle 9 on Reader-Service Card for more information

Sandwich Gives Bending Stiffness to

Edward W. Schrader, Western Editor

A welded-steel sandwich with two facing sheets and a corrugated core gives bending stiffness under external aerodynamic loading to the Saturn booster interstage fairing. The core and facing sheets of the sandwich approximate the shape of a truss when viewed in the transverse plane. There is a small flat at the corrugation crests to allow for placement of electrodes for spot welding core to face sheets.

This is a slight deviation from a pure truss. The sides of the core corrugations contain stiffening beads to increase the core's structural strength. This added strength permits reduction of the core sheet thickness. It gives the facing sheet a greater percentage of the total weight, thereby raising the structural efficiency of the sandwich.

The sandwich is 5/32 inch thick with a 0.002-inch-thick core and a 0.008-inch-thick facing. The sandwich weighs approximately as much as a solid sheet of steel 0.021 inch thick, yet it has a section modulus more than 17 times that of the solid sheet and a moment of inertia more than 140 times greater.

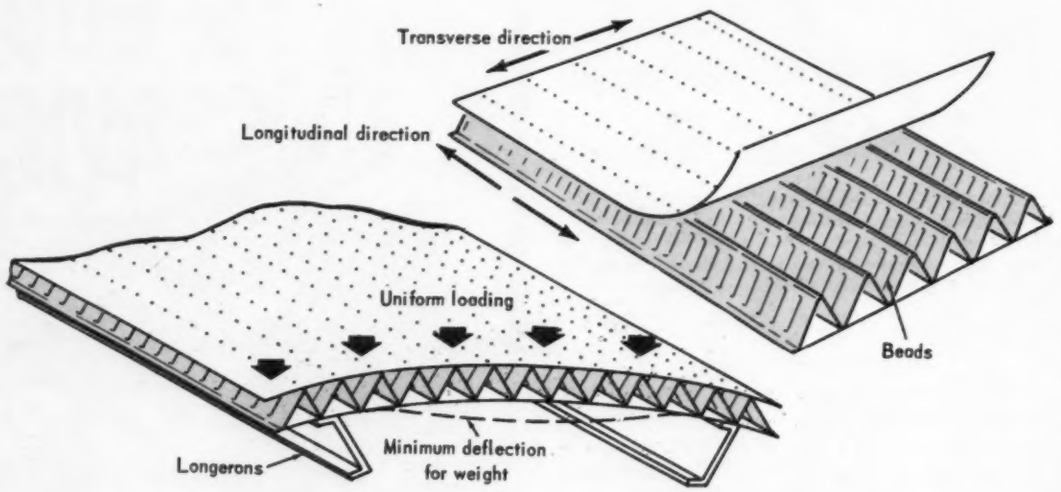
Design criteria for the interstage fairing require an ultimate safety factor of 1.25 and a yield safety factor of 1.15. An ultimate safety factor of 1.6 has been used on the umbilical door and support structure.

The interstage fairing is subjected to uniform external pressures of 5.8 psi on the conical portions and 0.70 psi on the cylindrical portions. In addition, a nonuniform pressure distribution exists in the form of a cosine variation whereby external pressures on opposite sides of the structure may differ by 0.36 psi.

These loads are applied under a temperature of 100F on the outer shell. The maximum temperature reached by the outer shell is 270F and occurs at first-stage cutoff. Upper-stage loading deflects the interstage structure radially outward 0.50 inch. At launch, loads on umbilical plates are 368 lb applied at each of four places and 480 lb on the support frames applied at each of two places.

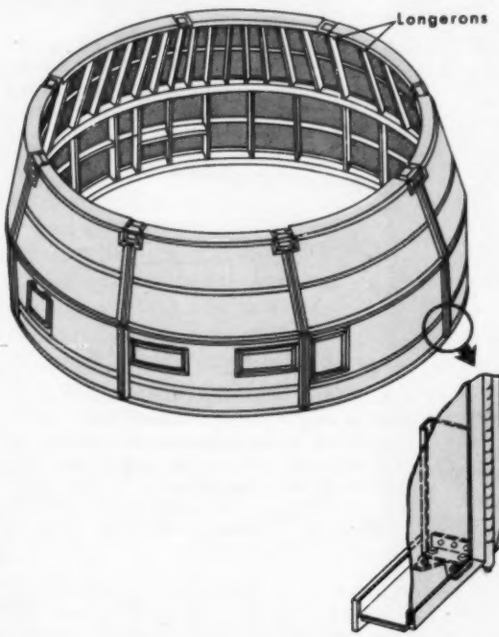
Sections of the steel sandwich are fastened to longerons by pull-type rivets. The sandwich transfers the aerodynamic loading to the vertically placed, channel-shape longerons. The latter in turn transfer the loading to hoops or rings circling the fairing, thus eliminating stringers, clips and extra fasteners.

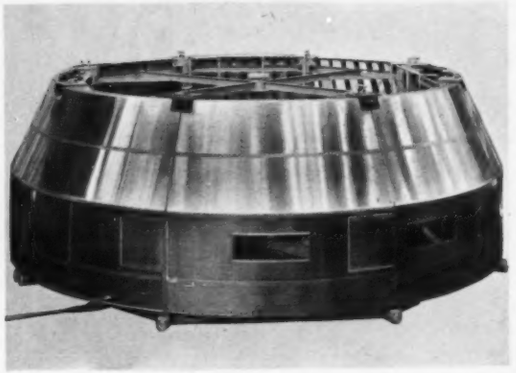
"Spacemetal" (registered trademark of North American Aviation, Inc.) sandwich material is a design development of the Space and Information Systems Div. (formerly the Missile Div.), North American Aviation, Inc., Downey, Calif. The interstage fairing is designed for the Saturn booster.



SANDWICH placed longitudinally transfers bending load to longerons. Removable panels in fairing also are covered with sandwich material.

Saturn Interstage Fairing





SATURN INTERSTAGE FAIRING consists of cylindrical section, 45 inches high and 261 inches in diameter, and conical section, 45 inches high, 219 inches in diameter at top of cone. Sandwich core runs laterally around circumference to form skin. Transition ring connects base of cone to forward end of cylindrical section. Fairing protects equipment and instrumentation mounted in area between booster tanks and base of second stage. Piano hinges join eight removable segments or octants in each of conical and cylindrical shapes.

PROPERTY	ALLOWABLES (psi)					LOADING
	RT	300F	500F	700F	900F	
Edgewise compression						
Transverse (1)	25,000	23,000	22,000	19,000	18,000	Transverse
Longitudinal (2)						
120 psi test pressure (3)	80,000	70,000	65,000	63,000	60,000	
60 psi test pressure (3)	65,000	57,000	54,000	52,000	49,000	Longitudinal
Ultimate shear						
Transverse	95	90	85	78	73	Transverse
Longitudinal	700					
Shear modulus						
Transverse	4,300	4,100	3,800	3,400	3,200	Longitudinal
Longitudinal	31,000					
Tension ultimate						
Transverse (1)	154,000	83,000	83,000	70,000	66,000	Transverse
Longitudinal (2)	185,000		146,000	135,000	118,000	
Tension yield						
Transverse (1)	130,000		83,000	70,000	66,000	Longitudinal
Longitudinal (2)	130,000		102,000	95,000	83,000	

Notes:
1. 0.012 sq inch per inch of width for 0.006—inch faces, 0.016 for 0.008—inch faces.
2. 0.013 sq inch per inch of width for 0.006—inch faces, 0.017 for 0.008—inch faces.
3. Specify test pressure required. Production costs increase rapidly with higher pressures and corresponding allowables.

TABLE of design allowables for Spacemetal sandwich. Pressure values are internal hydrostatic pressures which can be reached without rupture or leakage.

WHETHER YOU

join wires

BY HAND OR MACHINE...

HERE'S A PROVEN WAY TO

keep costs down and improve your product

IDEAL

All-Plastic

WIRE CONNECTORS

- Priced as low or lower than ordinary connectors, they go on fast, last for the life of your product. **No troubles!**
- Specially formulated high-dielectric, high-strength all-plastic shell is virtually immune to all moisture and chemical action. **They stay "new" permanently!**
- Smooth, precision-molded threads start easily, screw on without damage to even finest wire strands. **Wires are locked on—can't fall off or shake loose!**
- Scientific knurling is easy on fingers, fits snugly into Ideal standard driver shanks. **Less fatigue, faster assembly line splices!**
- Ample skirt protects splice, prevents shorts. **Best insulation you can get!**
- Only 5 sizes handle practically all appliance, fixture and smaller machinery needs. Approved for 300V and 600V (1000V for fixtures). **Less specification and stocking problems!**

TRY THEM AT OUR EXPENSE! mail coupon for FREE sample assortment

NEW BROCHURE for design and production

Gives new technical data for production and design men. Complete selector charts for all sizes of All-Plastic Connectors for all approved wire combinations. Also useful product information of Ideal Wire-Nuts, Excel Porcelain Connectors and Wing-Nuts. **Facts you should have on the industry's most complete line of wire connectors. Mail coupon.**

IDEAL INDUSTRIES, Inc.
1443-I Park Avenue, Sycamore, Illinois

Please send ☐ new brochure on All-Plastic Connectors;
☐ Free Sample Assortment

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

Sold Through America's Leading Distributors
IN CANADA: IRVING SMITH, Ltd., Montreal

Circle 10 on Reader-Service Card for more information

EQUIPMENT BUILT BY AMF'S UNION MACHINERY DIVISION USES THESE VICKERS COMPONENTS

CUSTOM POWER PACKAGE—A double-ended 60 hp electric drive motor is the prime mover for the two main hydraulic drives—one powering the developer (30 to 50 hp), the other driving the incorporator (5 to 10 hp). Vickers also supplies auxiliary control valving as part of the complete package. For more details on customized or standard power packages contact your Vickers application engineer.

PISTON PUMPS—AMF's application employs variable-displacement pumps having electrical remote volume control. Industry's broadest standard line includes models with flows to 180 gpm and pressures to 5000 psi, plus a wide variety of controls. For additional information write today for Bulletins 61-81, 61-84 and Catalog 5001C.

HYDRAULIC MOTORS—This fixed-displacement motor is only one of a complete line that includes models for variable horsepower (constant torque) or constant horsepower (variable torque) output characteristics in ratings from fractional to hundreds of hp.

Vickers adjustable-speed hydrostatic drives offer many unique advantages and economies —especially for applications where there are problems of space, weight, fast acceleration, infinite speed or tension control, sudden braking or reversing, hazardous or corrosive surroundings.

VICKERS

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1504 · Detroit 32, Michigan

Circle 11 on Reader-Service Card

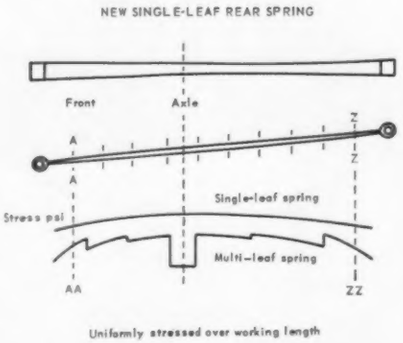
Rear Suspension of Chevy II Uses Single-Leaf Springs

E. J. Stefanides, Central States Editor

Uniformly stressed single-leaf springs are used in the Hotchkiss-type rear suspension of the new Chevy II line of cars. Providing a smooth quiet ride, the suspension is said to be an ideal arrangement for Hotchkiss drives and to be particularly adaptable to cars of this size and weight.

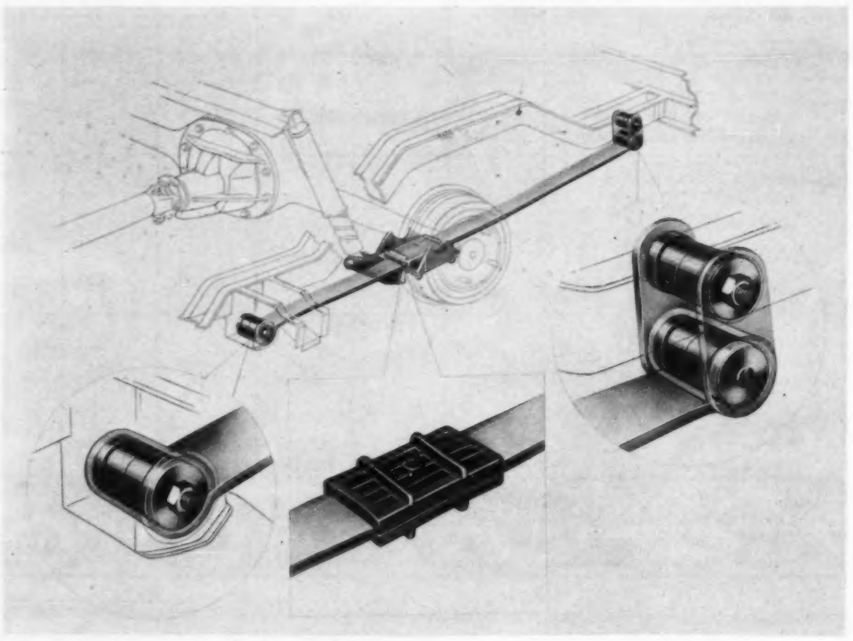
The springs are made of chrome-carbon steel. They are rolled and worked from rectangular bar stock in a special manner to produce a configuration in which width and thickness vary almost continuously along the length. Starting from a relatively deep section at axle center, thickness narrows to thinner sections at each end. In plan view the reverse occurs and the width at the axle center is smaller than at the ends.

When loaded as a flexible beam, the single-leaf spring is uniformly stressed throughout its working length. The stress distribution curve of the single-leaf spring is smooth and continuous, without the several sharp peaks and the



SINGLE-LEAF SPRING STRESS CURVE compared to that of multileaf spring. Stress curve of single-leaf spring is smooth and continuous since surface is uninterrupted by holes and because of soft mounting at center. Relative position on vertical scale indicates 25 percent higher stress level for single-leaf spring.

REAR SUSPENSION is of Hotchkiss type. Single-leaf springs are attached at front eye to rubber-bushed pin in welded-in bracket, to compression shackle at rear. Center of spring is sandwiched between rubber pads which isolate it from axle, permit it to work as flexible member along entire length.



CHEVY II is new intermediate-sized Chevrolet line. Both 4- and 6-cylinder OHV engines are available. Rear suspension system uses single-leaf springs.

sharp drop at the axle typical of the multileaf spring.

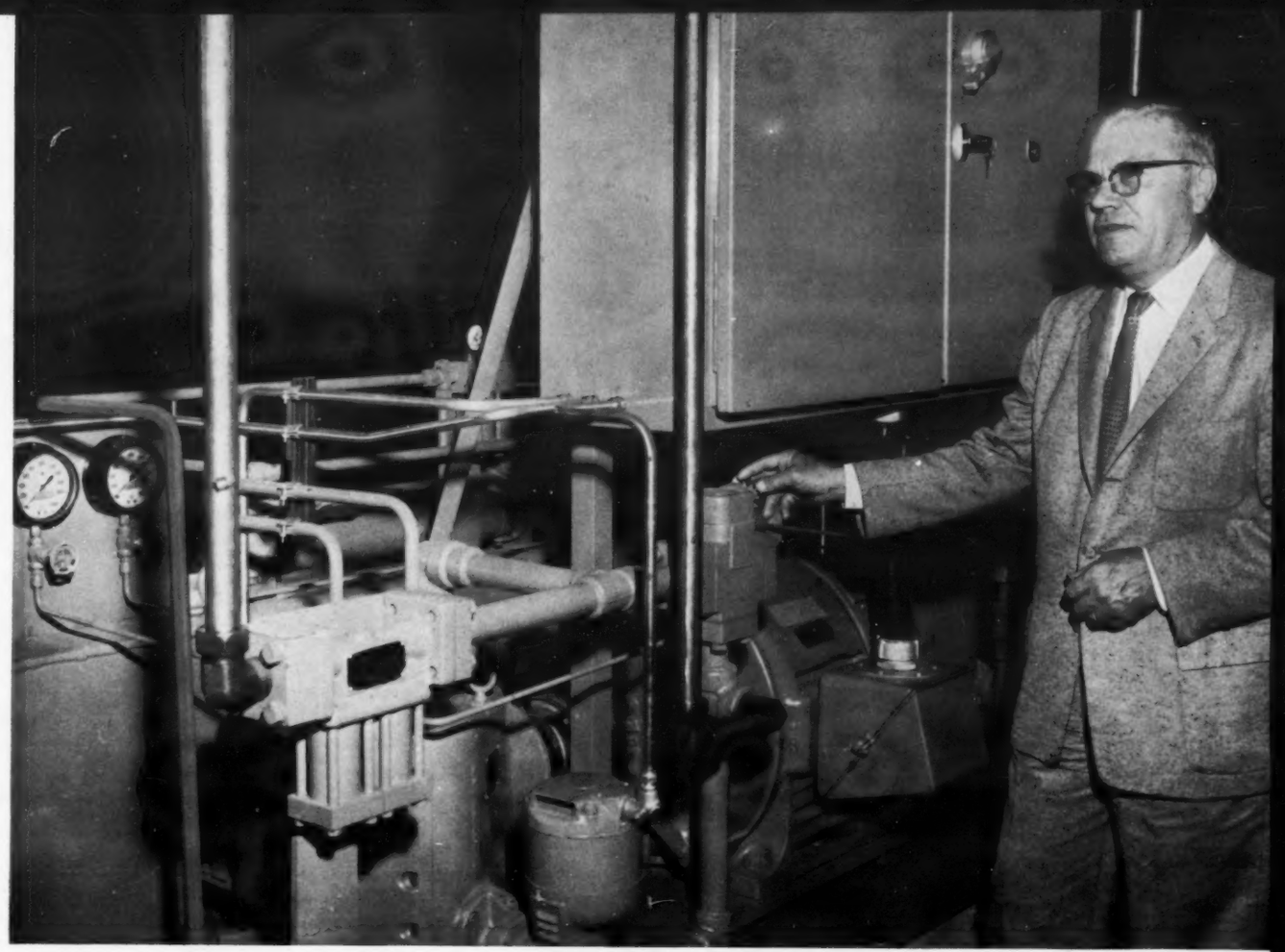
The maximum stress level in the single-leaf spring is more than 25 percent higher than in multileaf springs. This high stress level accounts for the relatively small dimension of the single-leaf unit. The stress level is made possible and compatible with fatigue requirements by an unusual shot-peening process. In this process, the spring's upper surface, and only the upper surface, is shot peened under tension equivalent to several inches of jounce. As a result, fatigue properties are increased up to 10 times those acquired through unstressed shot peening.

The spring's center portion is "sandwiched" between two heavy rubber pads isolating the spring from the axle. These pads and large rubber bushings at each end surround the spring at attaching points, holding it completely in rubber without metal-to-metal contact. The soft center fastening permits the spring to work as a flexing spring member virtually throughout its entire length.

The spring front eye is supported by rubber-bushed pin joints connected to a rigid welded-in hanger. Fore and aft spring movement is taken up by a compression shackle at rear of the spring, again with rubber bushing at the pin joints.

This suspension is used on the Chevy II, designed and manufactured by the Chevrolet Motor Div. of the General Motors Corp., Detroit, Mich.

Circle 12 on Reader-Service Card



MELBURN B. HANCOCK, CHIEF ENGINEER, AMF'S UNION MACHINERY DIV., SAYS:

"Hydraulics give us compactness, easy clean-up..."

"... accurate speed control, and freedom from noise and vibration in the operating area. Because the use of adjustable speed hydrostatic transmissions on bread machinery was, in a sense, a pioneering effort, we found it essential and helpful to work closely with Vickers engineers in developing a completely workable system that offered our customers advantages unobtainable elsewhere.

"Our speed control must be accurate since any speed variation may degrade the end product. This speed control is required from about one-half speed to maximum speed of the equipment. Also, the system must be extremely flexible since operating speeds vary from time to time depending on characteristics of the raw material.

"With hydraulics we are able to reduce the overall size of the equipment for the production area where space is at a premium. Combined with other space saving design features, this machine is smaller than would otherwise be possible.

"Last . . . but by no means least in the food industry . . . is the ease with which the machine can be cleaned (firehoses are usually used to wash down equipment) because hydraulic units are sealed from external moisture, etc. This is a daily operation on breadmaking machinery and is a major advantage to commercial bakeries."

Whether your requirement is for a refinement to existing methods of applying hydraulics or a completely new approach to providing power and control to machinery, Vickers design and application engineers are ready to work with you to effect the most efficient and economical solution. See facing page for more details about components and systems used by Union Machinery Division, American Machine & Foundry Co., and the overall Vickers line.

VICKERS®

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1504 • Detroit 32, Michigan

9713

New **LIMA**
GREEN SEAL
DRIPPROOF MOTORS

...are unconditionally warranted, if properly sized on application, and will be replaced FREE OF CHARGE if you experience any trouble.

- Special insulating materials assure longer motor life.
- Special dynamic balancing of rotor.
- Final protective coating of GREEN SEAL epoxy varnish.
- Special bearing lubricant.
- Slinger on motor shaft.
- Gasketed connection box.
- Corrosion resistant hardware.
- Corrosion resistant epoxy coating on rotor.

for additional information write to:
Darrel Bryan
general sales manager

LIMA

- ELECTRIC MOTORS (thru 150 HP NEMA)
- GEARSHIFT DRIVES
- VARIABLE SPEED DRIVES
- GEAR MOTORS
- GEAR REDUCERS
- STRAIGHT LINE REDUCERS
- SHAFT MOUNT REDUCERS
- GENERATORS

A Member of The Cordec Group

THE LIMA ELECTRIC MOTOR CO., INC.
LIMA, OHIO

Circle 13 on Reader-Service Card for more information

'Delrin' Arc Chute Provides Self-Extinguishing

E. J. Stefanides, Central States Editor

A load-break cutout uses an arc chute molded of "Delrin" acetal resin. This permits repeated interruption of high-load current without maintenance or replacement of expandable parts.

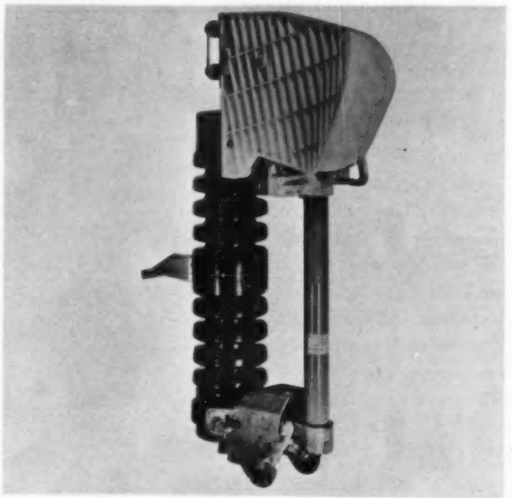
A normal arc is drawn during the load-break operation but is extinguished quickly (in less than 0.1 sec) by a de-ionizing gas generated within the chute from the resulting arc heat. The self-extinguishing action eliminates the need for breaking a fuse link or gas attachments when interrupting load.

Normally, load-break cutout devices are installed on utility poles and are directly exposed to the elements. The combination of this unfavorable environment and the mechanical and electrical properties required for best performance caused difficult problems in material specification for the key component, the arc chute.

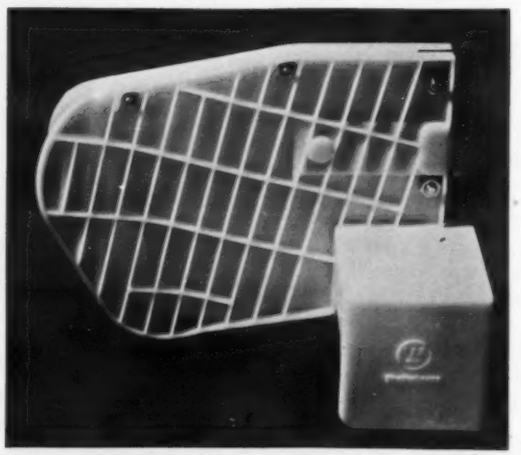
"Delrin" acetal resin was selected as the material for the arc chute because it presented the optimum combination of properties required to meet all the performance objectives and assured good service life under the unfavorable environmental conditions.

Mechanically, it provides the high strength, stiffness and creep resistance necessary to meet the structural requirements.

Electrically, it combines good electrical and insulating characteristics, unaffected by changes in moisture and temperature, with exceptional nontracking (noncarbonizing) characteristics. These nontracking characteristics permit successful repetitive arc interruptions even in fog or dust.



DISTRIBUTION LOAD-BREAK OUTPUT operates without expendable parts to provide safe, reliable interruption of loads up to 200 amps at 15 kv.



ARC CHUTE HALVES, or facing grids, are fabricated separately by injection molding and assembled with bolts to form structure in which quick-break blade operates.

Finally, it provides the durability to withstand exposure, toughness at low temperatures and high resistance to erosion and abrasion necessary to insure good service life in an outdoor environment.

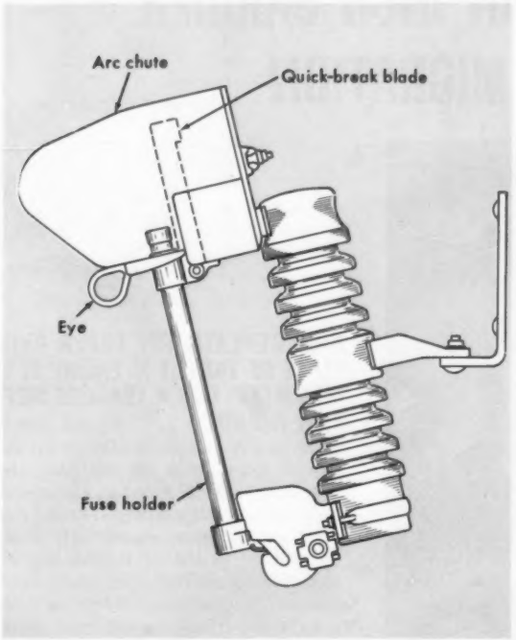
The reliability and consistency of performance afforded by these properties has been proved by extensive testing. In these tests, one unit underwent 200 load-break operations at 200 amps and 15 kv with a power factor of 70 percent, or higher, without failure.

Tests also were made under low temperature and icing conditions. These tests confirmed the low temperature toughness of the "Delrin" material as well as its nonadherent surface characteristics. Because of this nonstick property, contacts could be opened easily when coated with a half-inch layer of ice, most of the ice falling away from the chute.

The distribution load-break cutout was developed by the Distribution Apparatus Dept. of the Westinghouse Electric Corp., Bloomington, Ind.

Load-Break Action

TOP MAIN SET OF CONTACTS is paralleled by auxiliary set, equipped with quick-break blade, and located between facing grid-halves of arc chute. In operation, lineman inserts hookstick in fuse holder eye and pulls down opening contacts in sequence. Main contacts open first, auxiliary contacts continuing to carry current until main contacts are separated sufficiently to prevent arcing. At this point, strong spring action snaps quick-break blade away from auxiliary contact drawing an arc within chute. A de-ionizing gas is generated within "Delrin" plastic arc chute by arc heat. Combined action of blade and de-ionizing gas lengths arc almost instantaneously. Arc is extinguished quickly. To re-energize circuit, blade is pushed back into chute, remaking contacts.



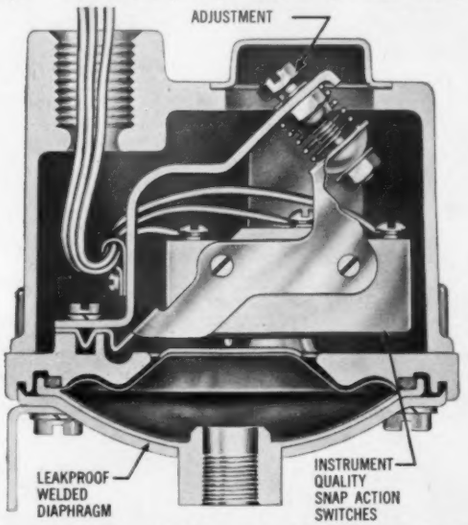
PROPERTY		VALUES	UNITS
Impact strength, Izod	−40F 73F	1.2 – 1.8 1.4 – 2.3	psi psi
Tensile strength and yield point	−68F 73F 158F	14,700 10,000 7,500	psi psi psi
Modulus of rigidity		178,000	psi
Heat distortion temperature	264 psi 66 psi	212 338	deg F deg F
Flammability		1.1	inches/min
Taber abrasion (1000 gm load, CS–17 wheel)		20	mg/1000 cycles
ELECTRICAL			
Dielectric constant 50 percent relative humidity, 73F, 10^2 – 10^6 cps		3.7	
Dissipation factor 50 percent relative humidity, 73F, 10^6 cps		0.0048	
Dielectric strength, short time		500	V/mil
Volume resistivity 73F and 0.2 percent water		(6) (10^{14})	ohm/cm
Surface resistivity 73F and 0.2 percent water		> 10^{16}	ohm
Arc resistance		129 (burns without tracking*)	seconds
* Flame extinguishes itself when arcing stops			

PARTIAL LIST of "Delrin" acetal resin properties significant in this application.

BREAKTHROUGH IN PRESSURE SWITCH ACCURACY

at reduced prices

The high accuracy associated with instruments costing several hundred dollars is now obtainable with new Barksdale pressure switches at a retail cost of $19.00 to $30.00. Accuracy of ±0.5% is guaranteed. Substantial price reduction is accomplished by use of erector set design and a major investment in production tooling. A wide choice of "tailored to the job" features meets your specification requirements exactly.



THESE POINTS ARE IMPORTANT

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	LINKAGES & BEARINGS which, as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements	LIQUID SWITCHING ELEMENTS which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	ACCORDION BELLOWS which make the pressure switch sensitive to vibration.

PRESSURE SWITCH DIVISION

Ask for new catalog and handbook

Barksdale valves

5125 Alcoa Avenue, Los Angeles 58, California

Circle 14 on Reader-Service Card for more information

75-MILLIONTHS OF AN INCH BARRIER HALTS METAL MIGRATION

JUST BENEATH THE FRESH OVERPLATE OF THESE F-M ENGINE BEARINGS (LEFT) LIES A TENUOUS DIFFUSION BARRIER. Though this film of metal is only 75-millionths of an inch thin, it stops tin in the overplate from migrating into the lining metal beneath. Its presence is important to bearing overplate performance, particularly during the critical period of engine break-in. Maintaining uniform thinness as well as uniform composition of the plated barrier is most important . . . and most difficult to achieve on a production scale. Federal-Mogul research has developed a unique, extraordinarily precise method for controlling both the thinness and the metallic composition of this barrier, within narrow limits. And the performance of F-M engine sleeve bearings attests to the success of the method!

RESEARCH INTO ELECTROPLATING problems is a continuing project in the F-M laboratories. Unusual precision equipment and facilities are employed, many of which have been specially designed and engineered by F-M to solve problems of sliding-bearing application. As a result, Federal-Mogul engineered sleeve bearings, precision thrust washers, formed bushings, and low-cost spacers provide the finest possible performance characteristics for any application.

FEDERAL Mogul

Have you a problem with bearings, bushings or washers? Are you considering the development or redesign of an item of the type shown above? We'll be glad to show you how the job can be done most effectively and economically. For information, write Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc., 11055 Shoemaker, Detroit 13, Michigan.

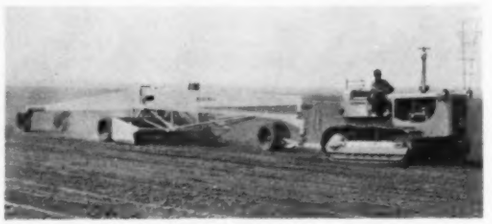
FEDERAL-MOGUL sleeve bearings bushings-spacers thrust washers DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC.

Circle 15 on Reader-Service Card for more information

Rectangular Tube Increases Rigidity of Scraper Plane

Edward W. Schrader, Western Editor

SCRAPER PLANE BOWL raises and lowers by means of articulated joint. Hydraulic cylinder extends to raise bowl. Center dual tires carry weight of dirt in bowl to eliminate vertical load on tailbeam.



TAILBEAM levels ground by keeping blade on proper grade line between front and rear wheels of machine. Dual rear caster wheels remove torsional loads from tailbeam when turning to give better bowl position control and prevent digging in while turning.

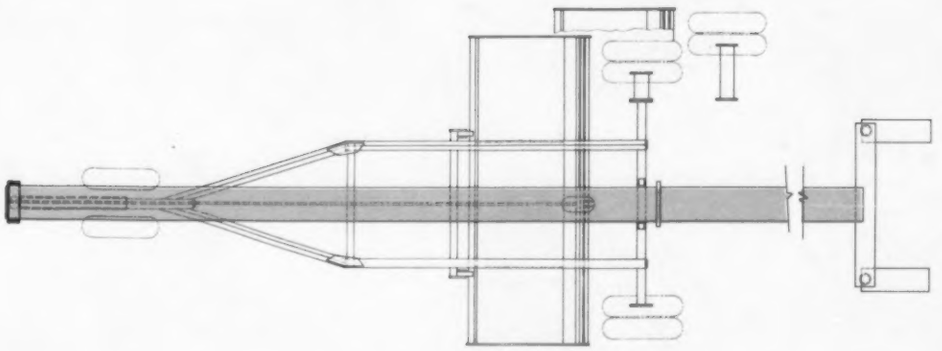
The rectangular cross-section tube for the main beam in a scraper plane has a high section modulus. The stressed-skin construction gives both a pleasing appearance and torsional rigidity for the 50-ft span. The main beam is made of folded 3/16-inch steel. The two tapered halves are slipped together and joined by single welds on either side. A 3/8-inch internal radius is maintained on the bends.

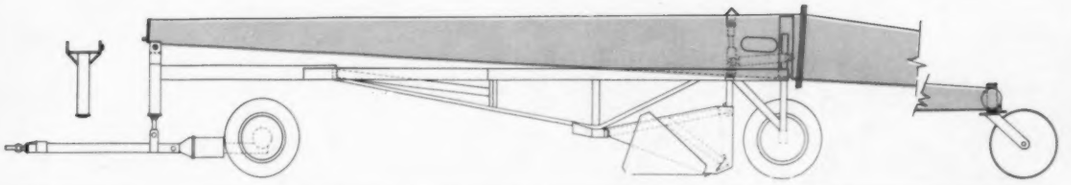
The scraper plane is an improved design to accomplish a better leveling action. Vertical deflection at the center is less than 3/16 inch for the 50-ft length span.

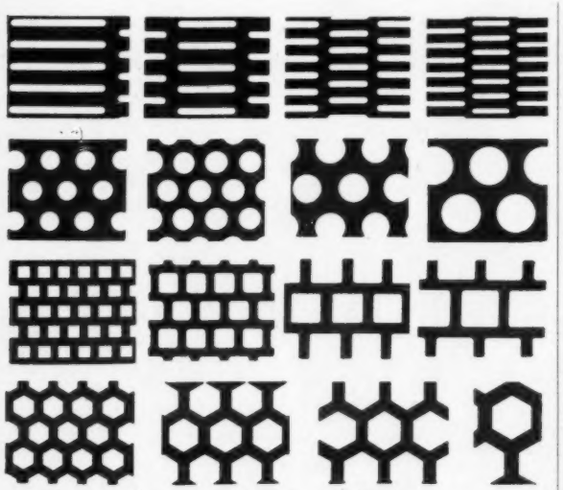
For transporting the machine, an articulated joint located at the center of the scraper plane elevates the bowl free of the ground. With the bowl locked to the frame, the twin, steel wheel casters on the end of the main beam rise clear of the ground.

The front truck is a walking-beam design which moves the front end of the main beam vertically one half the deviation experienced by the tractor or front wheels. When both the tractor and front wheels are on a "land trend" or change in elevation, true planing action is obtained by locating the bowl in the center of the plane.

The scraper plane is a design development of Be-Ge Mfg. Co., Gilroy, Calif.







put an extra plus in new products... HENDRICK perforated metal

Metalworking fabricators well know the importance of adding to product appearance **while the product is in the design stage.** That's why so many design engineers come to Hendrick for advice. Attractive Hendrick perforated metal is an invaluable material for manufacturers planning new design applications and product development. Hendrick perforated metals are available in a wide variety of patterns in every commercially rolled metal. Each can be supplied in a large number of sizes in plain or panel effects, with round, hexagon, square and squaround openings.

HENDRICK
Manufacturing Co.
Carbondale, Pa.

PERFORATED METAL • PERFORATED METAL SCREENS • WEDGE SLOT SCREENS • HENDRICK WEDGE WIRE SCREENS • ARCHITECTURAL GRILLES • MITCO OPEN STEEL FLOORING • SHUR-SITE TREADS • ARMORGRIDS • HYDRO DEHAZERS

Circle 16 on Reader-Service Card for more information

SPLIT-EYELET CONNECTORS

For faster, easier connection of spray nozzles, branch lines and equipment to piping and tubing carrying liquids, gases or air up to 250 psi. Write for Bulletin 93.

FOR BETTER PERFORMANCE

SPRAY NOZZLE ACCESSORIES

ADJUSTABLE JOINTS

For easy, exact adjustment of spray direction. Made in size for ¼" to 2½" pipe in brass, steel and stainless steel. Write for Bulletin 97.

...EASIER INSTALLATION

FOR COMPLETE SPRAY NOZZLE INFORMATION WRITE FOR CATALOG 24

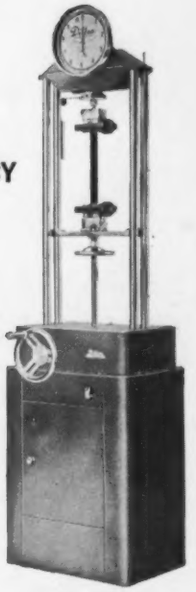
LINE STRAINERS

Special non-collapsing screen design for pressures up to 125 psi, for all pipe lines from ¼" to 6" size. Also high pressure strainers for up to 5,000 psi service. Write for Bulletin 94.

SPRAYING SYSTEMS CO.
3241 RANDOLPH STREET • BELLWOOD, ILL.

Circle 17 on Reader-Service Card for more information

AVOID COSTLY ERRORS WITH GUARANTEED *Dillon* ACCURACY WHEN YOU...



TEST...
In TENSILE • COMPRESSION
TRANSVERSE • SHEAR

MEASURE...
In TENSION OR COMPRESSION

OR

CONTROL
TEMPERATURE
(FAHRENHEIT-CENTIGRADE)

Bring ASTM & Federal Accuracy into your own shop —at a fraction of outside service charges!

YOU DON'T HAVE TO BE AN EXPERT to secure EXPERT results with Dillon instruments. These precision products are calibrated with *Certified* test weights, elastic proving rings and testing machines whose accuracy is directly traceable to the U.S. Bureau of Standards! Every desirable feature is included. Seldom used, expensive extras are eliminated. In the laboratory or on the production line, Dillon equipment will provide you with *vital* test data exactly as you need it—*when* you need it!

PLEASE BE SURE TO MENTION PRODUCT IN WHICH YOU ARE *SPECIFICALLY* INTERESTED. A COPY OF OUR *GENERAL* CATALOG ON *OTHER* DILLON PRODUCTS WILL BE INCLUDED.-235

TO MEASURE, WEIGH, TEST OR CONTROL – CALL ON DILLON ...PRECISION INSTRUMENTS FOR 3 DECADES!

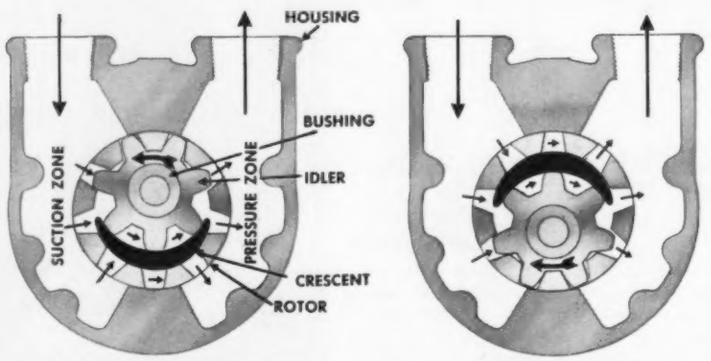
W. C. *Dillon* & COMPANY, INC.
DEPT. 104, 14566 KESWICK STREET, VAN NUYS 79, CALIFORNIA
Representatives in All Principal Cities

Circle 18 on Reader-Service Card for more information

The TUTHILL Internal Gear Pump . . . and its advantages in reversing applications

by E. H. Schanzlin,
Chief Engr., Tuthill Pump Co.

Extremely high reliability, proven in thousands of applications over a 30 year period, has made Tuthill's internal gear pump an industry standard. The Internal gear construction particularly adapts itself to reversing pump applications as indicated in the sketches at right.



How It Operates

Key elements are the rotor, idler gear and the crescent shaped partition. This crescent shaped partition, shown in heavy black, is cast integral with a moving part called the idler carrier.

In the drawing at left, power is applied in counterclockwise rotation to the rotor and transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the rotor is sealed by the crescent. When the pump is started, there is an increase in volume as the teeth come out of mesh. This creates a partial vacuum, drawing the liquid into the pump through the suction port. The liquid fills the spaces between the teeth of the idler and rotor and is carried past the crescent to the pressure side of the pump. When the teeth mesh on the pressure side the liquid is forced from the spaces and out through the discharge port.

When shaft rotation is changed from counterclockwise to clockwise, as in the drawing at right above, the idler carrier, (including the idler gear and crescent) automatically rotates 180° through the suction zone. This changes the directional flow within the pump without changing port positions. The idler carrier rotates in a cover casting fitted with stops so that the crescent can rotate only 180° —always through the suction zone. If rotation were again reversed to counterclockwise, the crescent would swing back to its original position (shown at left above).

No valves required . . . ports remain constant

This unique construction permits positive reversing action, without any valves, and with the port positions remaining constant. In addition Tuthill's reversing pumps provide all the other attributes of internal gear construction . . . extremely high reliability, compactness, and high efficiency.

Reversing Pumps with internal gear construction pay particular dividends on applications where the pump must be driven from a reversing shaft or when machinery must be shipped without knowing the ultimate direction of the driving unit.

375 reversing pump models

Tuthill offers a complete selection of over 800 different pumps including 375 different reversing pump models for capacities from ⅓ to 200 GPM; for pressures to 400 PSI; and speeds to 1800 RPM. These include a complete selection of stripped models for incorporation into products. Specially designed housings, shaft extensions, relief valves and many other features can be developed by Tuthill's engineers to meet the requirements of specific applications.

Catalog 105 contains complete information on all Tuthill Reversing Pumps. Write today for your copy.

Typical Tuthill Reversing Pump. Model 2RC has capacity of 5 GPM operating at 100 PSI, 1200 RPM.

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1/3 to 200 GPM; for pressure to 300 PSI; speeds to 3600 RPM.

PUMPS FOR YOUR PURPOSE

TUTHILL PUMP COMPANY

943 East 95th Street, Chicago 19, Illinois

Circle 19 on Reader-Service Card for more information

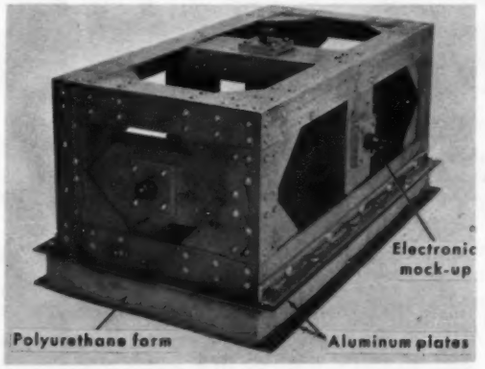
Polyurethane Foam

Victor W. Wigotsky, Eastern Editor

Flexible polyurethane foam provides simultaneous shock and vibration protection in a new isolation system. The foam is cemented between two aluminum alloy plates which then are fastened to the aircraft structure and the equipment.

Specification MIL C-172-C, for airborne electronic systems, requires isolators to be resonant under 15 cps (lower than the natural frequencies of most of the aircraft structure). For this resonant point the standard isolators, basically metal spring elements, perform acceptably in protecting equipment from vibration. However, they considerably aggravate the shock condition and amplify the shock pulse passing into the equipment. Tests indicate that, with standard isolators, bottoming usually occurs at less than 2Gs input and that the shock pulse may be amplified as much as 1000 percent. Since 2G is within the normal aircraft environment, the bottoming cycle occurs many times and thus contributes to malfunctioning and failures of the electronic equipment.

The flexible polyurethane foam, however, acts



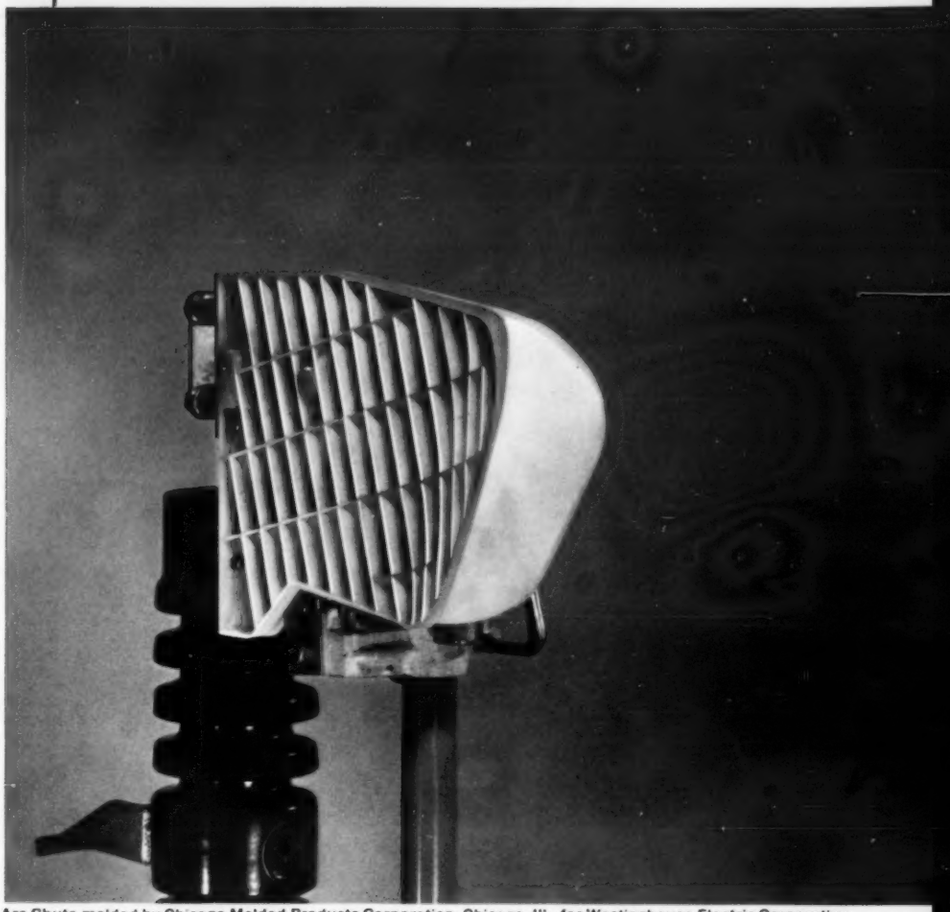
TESTS INDICATE that flexible polyurethane foam possesses properties needed to meet aircraft environmental shock and vibration requirements. Foam is cemented to mounting rack on top and screws are attached to bottom plate to mate with existing mounting holes and air frame. On new installations, four mounting screws are sufficient. Because flexible plastic foam is organic material, it was necessary to test for all environmental conditions. Isolation pad, with AN/ARC-27 transceiver mounted on it, has been undergoing flight tests in airplane (five-seater twin-engine) and Navy helicopter and for 6 and 4 months, respectively, with very good results.

Circle 20 on Reader-Service Card

working with

Du Pont Delrin

one of Du Pont's versatile engineering materials



Arc Chute molded by Chicago Molded Products Corporation, Chicago, Ill., for Westinghouse Electric Corporation

Significant advance in load-break design made possible by using DELRIN® for arc chute

New electrical cutout device features a self-contained load-break, designed to permit repetitive interruptions of high load currents throughout its life without maintenance or replacement of parts (such as fuse links and gas bottles). The significant advance in design is made possible by the use of Du Pont's DELRIN acetal resin for the arc chute through which the contact blade is pulled. Load-break operation is achieved by lowering the knife switch between the facing grids of the chute away from the contact points. The normal arc is quickly extinguished (less than 0.1 second) by a de-ionizing gas generated inside the chute from the resulting arc heat.

The arc chute of DELRIN lasts the life of the cutout, is safe and reliable. Units have been tested for 200 load-break operations at 200 amps, 15KV with a circuit power factor of 70% or higher. Inspection showed negligible wear, only very slight discoloration and no evidence of carbon tracking.

Only DELRIN offered the required combination of properties: high strength, stiffness and creep resistance; exceptional non-tracking and non-carbonizing characteristics; high resistance to erosion and abrasion; durability under outdoor exposure; toughness at low temperatures; good insulating characteristics unaffected by variations in moisture and temperature; and a non-adherent surface.

See the next page for more examples of what DELRIN is doing to improve products and reduce costs.

DU PONT

REG U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

working with

Du Pont Delrin®

one of Du Pont's versatile engineering materials

This molded ring of DELRIN is key unit of a simplified bearing system for the revolving drum of an RCA Whirlpool dryer. The bearing design requirements, which led directly to DELRIN, included excellent frictional properties, abrasion resistance, dimensional stability and retention of physical properties in a moist atmosphere at temperatures up to 200°F., and freedom from warpage. (Molded by Haas Molding Co., Mendon, Michigan, for Whirlpool Corporation, St. Joseph, Michigan.)

DELRIN has replaced an expensive two-piece, spot-welded and copperplated, stamped-steel component in fluorescent light-starter switch. The new one-piece injection-molded part is used as a lock spring. DELRIN acetal resin is a good electrical insulator, has excellent resilience, which gives it the spring-like properties needed here, wear resistance and dimensional stability; costs about half of previous metal component. (Molded by Waterbury Company, Waterbury, Connecticut, for Edwin Gaynor Co., Bridgeport, Connecticut.)

A clamp-on hand brake for cotton spinning spindles uses DELRIN for the handle, the cam and two brake arms. The flexing arms of tough, resilient DELRIN provide automatic adjustment and take-up for wear. DELRIN is easily molded in the complex shapes required, eliminates the need for machining operations. (By Brook Molding Company, Norwood, Mass., for Whitin Machine Works, Whitinsville, Mass.)

Light, tough and resilient DELRIN® simplifies designs . . . cuts costs

Sometimes the simple substitution of a part of DELRIN for a metal part answers a design problem and saves money by eliminating finishing operations and making possible rapid, low-cost injection-molding production. Very frequently, however, the use of DELRIN permits a thorough redesign of a component, with increased operating efficiency, fewer parts, lower assembly costs, lower shipping costs. The resultant cost advantages can be substantial. It will be worth your while to investigate the properties of DELRIN as they apply to your design problems, and to find out more about the many hundreds of production improvements at lower cost that this new material has made possible. Simply mail the coupon below for pertinent information.

POLYCHEMICALS DEPARTMENT

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.), Dept. 3
Room 2507D Nemours Building, Wilmington 98, Delaware
I am interested in evaluating DELRIN for the following use:

A
B
C
D

_____

*Name*_____

*Company*_____ *Position*_____

*Street*_____

*City*_____ *Zone*____ *State*_____

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

DELRIN® *acetal resins*

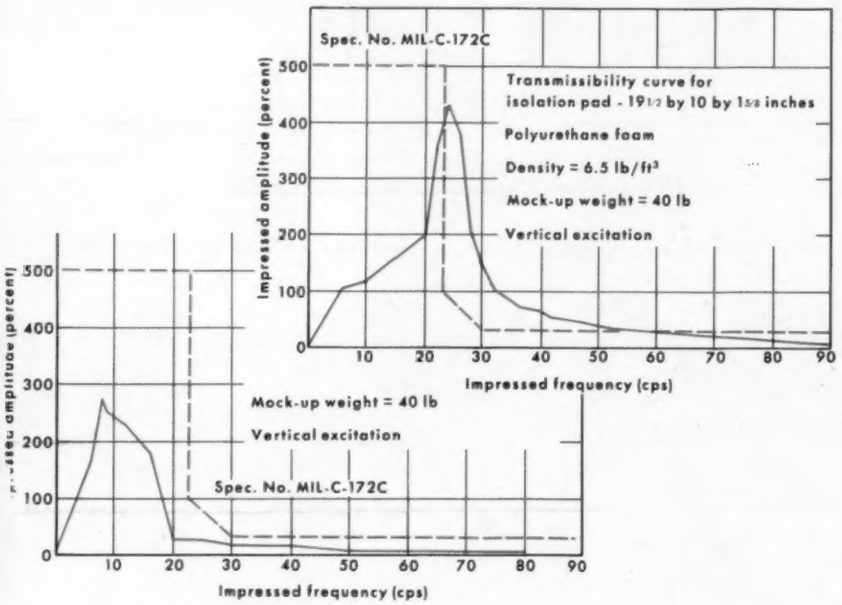
one of Du Pont's versatile engineering materials

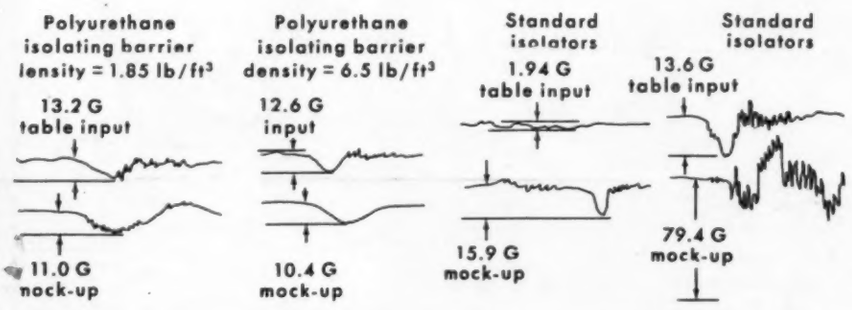
Alathon® · Zytel® · Lucite®

›imultaneously Isolates Shock and Vibration

as a nonlinear spring which simultaneously absorbs most of the energy of both shock and vibration. The determining factor in the design of the pad for a particular installation (combination of lensity, thickness and area) is governed by the natural frequency desired in vibration. Density and thickness of the isolation pad have little effect on the variation of transmissibility in shock. In most cases, a half-inch-thick pad provides adequate protection. This permits over one-inch saving in height.

The simultaneous shock and vibration isolation system was developed by Arthur A. Cohen, Mechanical Engineer, U. S. Naval Air Development Center, Johnsville, Pa.

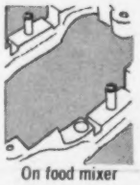




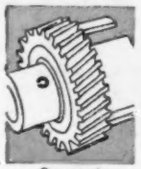
ESULTS of tests in vertical vibration for plasc foam with densities of 1.8 lb/cu ft. and 6.5 ·/cu ft, together with transmissibilities permitd by specification Mil-C-172-C. Typical oscillograms of shock pulses illustrate significant imovement in shock isolation of foam. Using standard isolators, 1.94G table input resulted in 15.9G shock pulse in mock-up shock pulse. With polyurethane foam, 13.2G input was attenuated to 11.0G, using 1.85 lb/cu ft isolator, and 12.6G input was attenuated to 10.4G shock pulse in mock-up, using 6.5 lb/cu ft isolator.

ircle 20 on Reader-Service Card

Use it for positioning... SEL-LOK spring pin

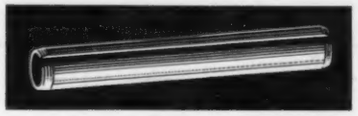

On food mixer

On hacksaw


On gear in assembly

- Swift fastening—just drill and drive
- Secure locking—won't work loose despite shock or vibration
- Eliminates costly tapping, reaming, peening, milling
- Can be reused repeatedly
- 101 uses—as keys, cotter pins, axles, hinge pins, wrist pins, stop pins, pivots, etc.

SEL-LOK spring pins are available in carbon and corrosion-resistant steel (from 1/16 x 3/16 through ½ x 4 in.) and beryllium copper (1/16 x 3/16 through ¼ x 3½ in.). See your SPS distributor or write for Bulletin 2670.



INDUSTRIAL FASTENER Division SPS

JENKINTOWN 6, PENNSYLVANIA

Circle 21 on Reader-Service Card for more information

LepeL

High Frequency Induction

HEATING EQUIPMENT

For Hardening • Annealing • Soldering
Brazing • Zone Refining • Crystal Growing

WRITE FOR THE NEW LEPEL CATALOG 36 illustrated pages of valuable information.

LepeL HIGH FREQUENCY LABORATORIES, INC.

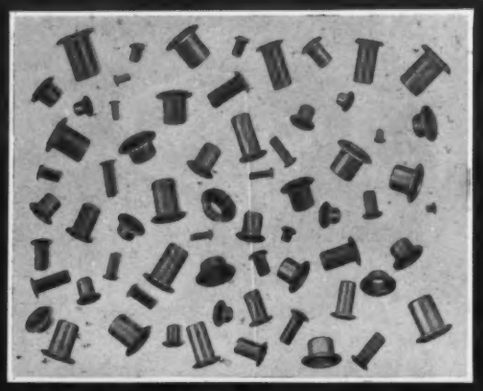
55th ST. & 37th AVE., WOODSIDE 77, N. Y.

CHICAGO OFFICE: 6246 WEST NORTH AVE.

Circle 22 on Reader-Service Card for more information

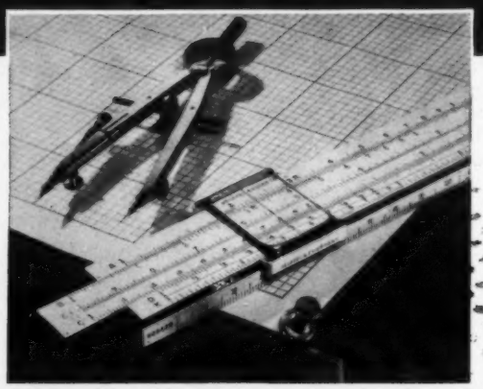
The only true measure of

eyelet price



Installed Cost

*IC Installed Cost . . . not the initial cost of eyelets, but the total cost when the eyelets have been installed in your product.



and here's JUST ONE of the ways UNITED helps you cut IC:

REDUCED ENGINEERING COSTS!

With United's system of standardized eyelet sizes, you no longer have to hunt through literally thousands of cataloged items to find the right eyelet. 60 years of experience prove that United's 65 standard sizes will handle a vast majority of all eyeleting applications. As a result, your engineering specification time is cut to a bare minimum! Of course, there are always occasions when unusual application needs or exceptional production requirements call for special eyelet types or sizes . . . or special eyelet tooling. But here again, United helps cut your engineering costs, because you can call on our complete application engineering service for the specialized assistance you need.

for all the dollar-saving facts . . . that show how United can help you cut Installed Costs through lower engineering costs (and through lower tooling, down-time and acquisition costs), ask for your free copy of the new bulletin "Eyelets and Price Buying." Simply phone the United office in your area or write direct to Fastener Division, United Shoe Machinery Corporation, 1955 River Road, Shelton, Connecticut.

SE EYELETS

United Eyelets

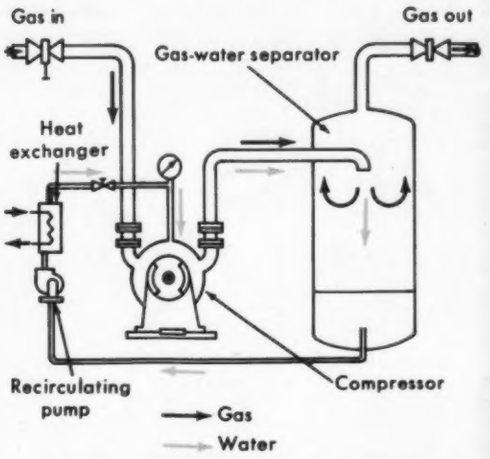
Fastener Division — UNITED SHOE MACHINERY CORPORATION — Shelton, Connecticut

BRANCHES: ATLANTA, GA. • CHICAGO, ILL. • CINCINNATI, CLEVELAND AND COLUMBUS, OHIO • DALLAS, TEXAS • HARRISBURG, PA. • JOHNSON CITY, N.Y. • LOS ANGELES, CALIF. • LYNCHBURG, VA. • MILWAUKEE, WISC. • NASHVILLE, TENN. • NEW YORK, N.Y. • PHILADELPHIA, PA. • ROCHESTER, N.Y. • ST. LOUIS, MO.

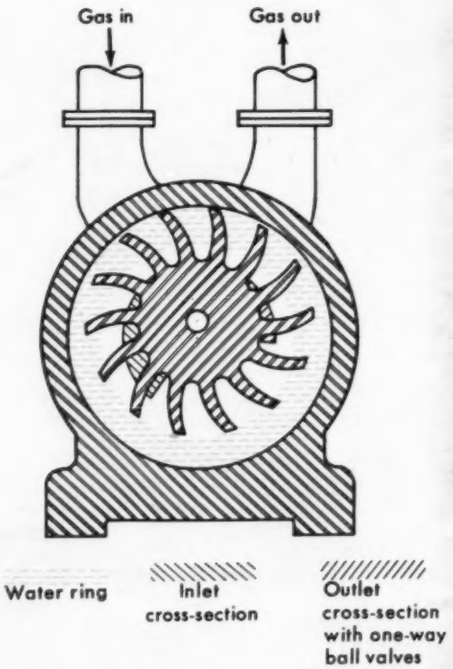
Circle 23 on Reader-Service Card for more information

Titanium Impeller Adapts Pump

R. F. Stengel, German Editor



WATER RECIRCULATION FLOW SHEET

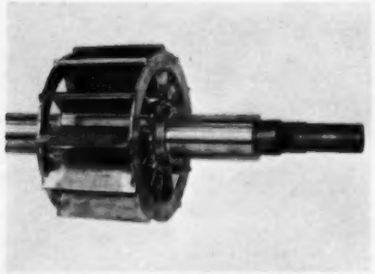


IMPELLER MOTION forces water into peripheral ring. Gas admitted through inlet cross-section is trapped in pockets formed between blades and water. As impeller turns, eccentricity of impeller in casing reduces gas volume in pocket. Isothermally compressed gas leaves through exit ports.

to Corrosive Service

A series of liquid-seal pumps uses an all-titanium impeller welded together from end discs, constant-thickness blades and a stepped shaft. Use of titanium, together with a rubber coating on casing and end covers, adapts the pumps to service under highly corrosive conditions. Complete installations for chemical process industries also include closed-circuit reprocessing of the operating liquid, keeping it out of normal plant piping.

Cooled and lubricated double



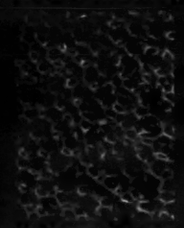
stuffing boxes with a liquid-seal chamber reduce pressure losses. A slight, intentional outward seepage blocks oil and minimizes explosion hazards. Since the operating liquid absorbs the heat of compression, easily decomposing gases like acetylene or carbon disulfide can be handled safely.

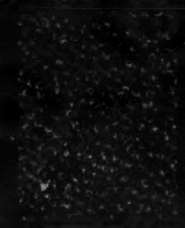
The present one-stage series is rated for 11, 21, 43 and 85 psig discharge pressures and handles up to 2100 cfm. The pumps were designed by Siemens-Schuckertwerke AG, Erlangen, Germany.

Circle 24 on Reader-Service Card

This versatile product may have a place in your design. Scott Industrial Foam, a unique "open pore" urethane, comes in a wide variety of pore sizes, some of which are shown below. It can be readily cut to any shape. Easy to clean, strong, resilient. Has 97% void volume. Already in wide use for demisting, liquid detraining, coalescing, and even powder puffs. It revolutionized the air filtration industry. Can it revolutionize yours? Write Ed Mack, Manager, Industrial Sales, Foam Division, Scott Paper Co., Chester, Pa., for free bulletin giving complete technical details.

SCOTT INDUSTRIAL FOAM
another product of research by
Scott Paper Company


10 PORES PER INCH


20 PORES PER INCH

30 PORES PER INCH

60 PORES PER INCH

80 PORES PER INCH

FREE BULLETIN

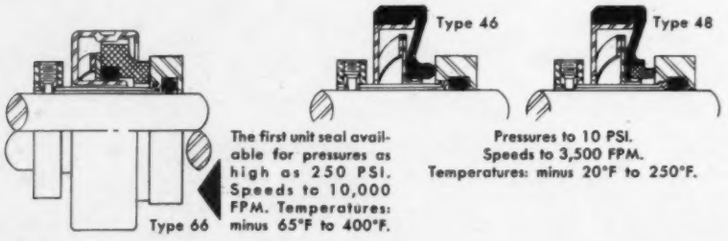
NEW!
GITS BRINGS FACE SEALING DOWN TO LIP SEAL COST RANGE

GITS BROS.' Research and Engineering Staff has "cracked the cost barrier" with face type unit* shaft sealing that compares favorably in over-all cost with lip type sealing. This new family of seals (three types) can be an ideal solution in applications where lip seals "don't do the job" or where some face seals are too high-priced.

Consider these economy advantages: low initial cost; no special and costly shaft preparation; simple hand installation (on some models); no shaft wear; seals may be disassembled and the seal faces reconditioned, to effect longer seal life and ease of service "out in the field."

For speed reducers, gear motors, machine tools, construction equipment, home appliances, hydraulic pumps, industrial pumps, aircraft, many other applications. Write for complete Engineering Data File on these and other Gits Shaft Seals.

**Contains both stationary seal face and positive-drive mating ring factory assembled as one unit.*


Type 46
Type 48
Type 66
The first unit seal available for pressures as high as 250 PSI. Speeds to 10,000 FPM. Temperatures: minus 65°F to 400°F.
Pressures to 10 PSI. Speeds to 3,500 FPM. Temperatures: minus 20°F to 250°F.

GITS BROS. MFG. CO.

Specialists in Lubricating Devices and Shaft Seals for More Than Half-A-Century

1866 South Kilbourn Avenue
Chicago 23, Illinois

Circle 25 on Reader-Service Card for more information

Powder Metallurgy Parts

E. J. Stefanides, Central States Editor

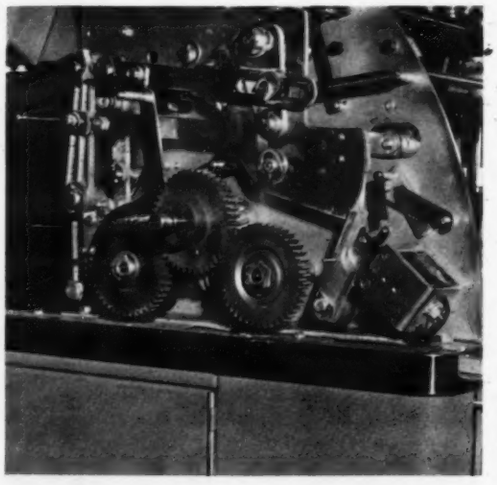
The self-damping properties of powder metallurgy parts improve business machine performance by providing quieter and smoother operation. Their use also effects a significant cost savings by utilizing the high-production capabilities of the powder metallurgy process.

These parts are used in a mechanism for raising and lowering the paper feed table of various duplicating machines. Parts are produced from Gramix Grade 331, a metal-infiltrated steel. They are surface hardened after sintering by a carbonitriding process to secure maximum wear resistance.

One part is a ratchet, 3 inches in dia by 1/4 inch thick, with 10 equally-spaced teeth. After carbonitriding it is swedged to the hub of a 42-tooth involute spur gear, produced by the same process.

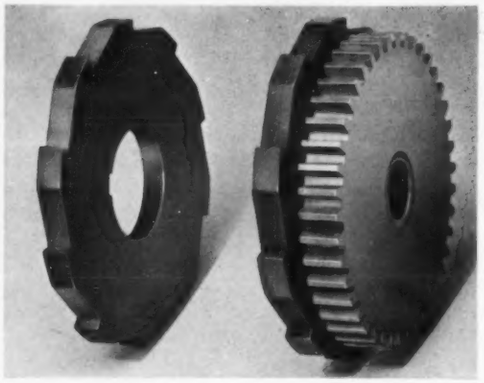
Another part is a 43-tooth idler gear with an integral hub and key. The accuracy of this method allows the concentricity of the pitch diameter to the bore to be held within 0.005 inch total indicator reading for both these gears.

Improved accuracy is attributable to the inherent precision of the process. A true involute-form tooth can be produced more accurately in

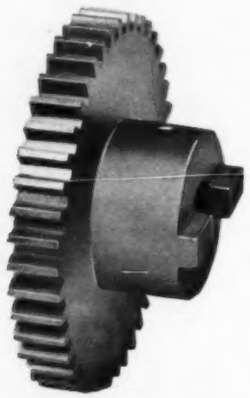


MECHANISM for raising and lowering of duplicating machine's paper feed table. Gears are produced of Gramix Grade 331 metal-infiltrated steel with a density of 7.0 ±0.2 gram per cubic centimeter.

Silence Machine Operation



GEAR AND RATCHET ASSEMBLY PARTS are produced separately and assembled by swedging after carbonitriding.



43-TOOTH IDLER GEAR has pitch diameter of 2.6875 inches and is produced with integral hub and key. Key engages in mating slot in handle to provide for manual raising and lowering of paper feed table.

this way than by any other method and accuracy is maintained over long production runs. When dies are accurately made and carefully maintained, surfaces of the teeth produced are smoother than on cut gears because of the absence of tool marks. This results in improved rolling contact.

The business machines using these components are designed and manufactured by the Addressograph-Multigraph Corp., Cleveland, Ohio. The powder metallurgy parts are produced by the United States Graphite Co., Saginaw, Mich., a division of the Wickes Corp.

WHO SAID IT COULDN'T BE DONE?

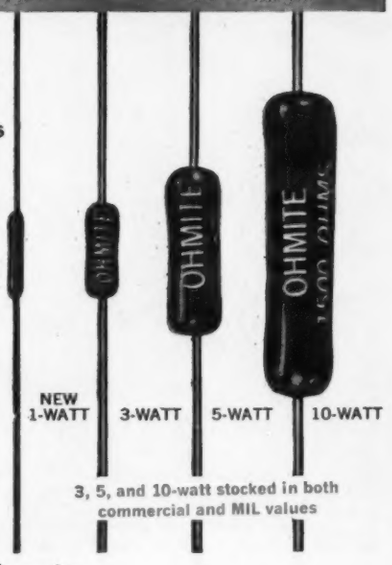
OHMITE'S
NEW ONE-WATT
Vitreous-Enameled
Resistor
With Axial Leads

Lots of people thought this tiny "1-watter" was impossible. But here it is. And for the first time in this power rating, circuit designers can get all the advantages of a wire-wound, vitreous-enameled resistor with axial leads—high temperature operation, up to 350°C; ±5% tolerance; low temperature coefficient; low "noise" level; stability; and strong, welded construction.

Construction is the same as Ohmite's 3, 5, and 10-watt sizes—including ceramic core, uniform winding, tough Ohmite vitreous enamel coating, and traditional Ohmite reliability.

Resistance values range from 1 to 6000 ohms. But you can find out all about this *exclusive* Ohmite development by writing for *Bulletin 147F. Do it now!*

Now 4 Sizes



3, 5, and 10-watt stocked in both commercial and MIL values

OHMITE MANUFACTURING COMPANY
3616 Howard Street
Skokie, Illinois

Rheostats Power Resistors
Precision Resistors Variable Transformers
Tantalum Capacitors Tap Switches
Relays R.F. Chokes
Germanium Diodes Micromodules

OHMITE

Circle 26 on Reader-Service Card for more information

Another Parco Pace Setter

Parco's Research Engineers have done it! Not just an experiment but a fully operational high tensile strength bonded part composed of three different materials economically bonded in one operation. This unique Parco development now permits the advantages of Teflon's anti-stick characteristics, low friction operation, durability and low wear to be combined with the resiliency of rubber and the rigidity of metal. The one last hurdle in Teflon's universal application... its lack of resiliency... has now been successfully conquered by Parco Engineers without the use of extraneous springs or complicated machining. □ Consult your local Parco representative today and find out how this unique bonding development can help solve your problems.

FLUOROCARBON DIVISION
PLASTIC AND RUBBER PRODUCTS COMPANY
2100 Hyde Park Boulevard, Los Angeles 47, Calif. • AXminster 5-4331

*REGISTERED DUPONT TRADEMARK

Circle 27 on Reader-Service Card for more information

Asbestos-'Teflon' Packing Prevents Valve Leakage

Victor W. Wigotsky, Eastern Editor

An asbestos packing, impregnated with "Teflon", significantly reduces maintenance of a motor-operated valve assembly. The combination of asbestos and "Teflon" prevents change in packing volume. This avoids binding and/or leakage in the valve assembly.

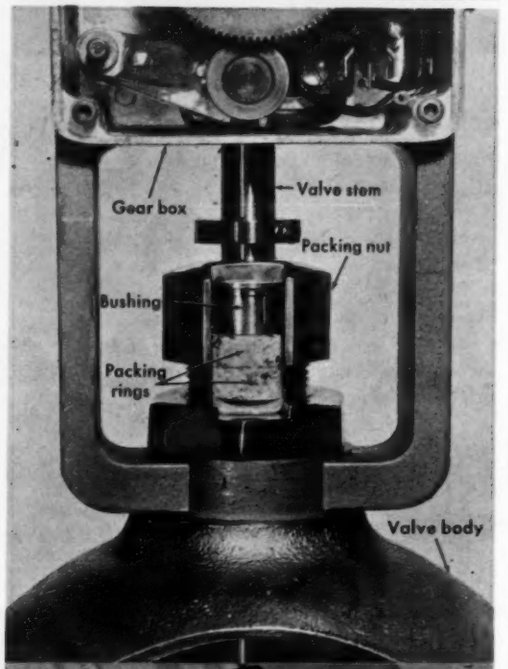
The motor-operated valve functions as a temperature control device in heating and air-conditioning systems. Previously, a graphite and asbestos string packing was used. However, the original packing swelled in service, because of absorption of moisture, and would then shrink during overnight shutdown. Operation at temperatures between 230 and 450F also caused loss of lubricant, which additionally reduced the packing volume. Steam then entered the gear box, condensed and caused rusting and inefficient operation. These conditions created severe maintenance problems.

The new packing is less subject to volume change because of the zero-moisture absorption characteristic of the "Teflon". This assures an effective seal between valve and gear box and thus prevents the rusting that was encountered previously.

The combination also solves a previous problem of sticking of the valve stem. The graphite and an additional lubricant were not adequately maintained in the string packing under high-temperature operation and frequent cycling. Resulting excessive friction and stiffness hindered stem movement.

The string packing also generated high breakaway friction which resulted in valve malfunction. Low friction coefficient of the "Teflon", on the other hand, compensates for the frictional qualities of the asbestos. In addition, the asbestos yarn inhibits creep so that the valve can operate up to 500F.

The R/M No. RL-715 packing is furnished as a die-formed ring and was developed by the Packing Division, Raybestos-Manhattan, Inc., Passaic, N.J., for the motor-operated valve assembly manufactured by New England Gear Works, Southington, Conn.



PACKING prevents water in gear box and damaged electrical system. Extended life of seal, through stability against swelling and shrinkage, eliminates persistent field maintenance to correct leakage. Control device is two-position unit consisting of gear-motor operator and globe valve body. Valve operates in response to automatic switches such as thermostats to regulate temperature-control systems.

Some Ideas

K+E

for your file of practical information on drafting and reproduction

KEUFFEL & ESSER CO.

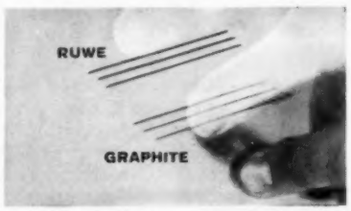
The stone tablet and chisel were pretty widely used writing and drawing instruments in their day.

But they don't command much of a following any longer. Like so many tools of the past, they gave way to better methods of portraying information. Some of these methods occurred by accident, some were developed by experts to serve specialized needs. Three good examples of the latter are described here.

A Couple of "Better" Pencils

When polyester drafting film first came into use, it was found that standard graphite pencils with clay binders, while fine for paper, smudged too readily on film.

So a new kind of pencil was needed—and developed. It was called the Duralar. With both binder and color agent made entirely of plastic, Duralar deposited a black, dense line on film, which could neither be smudged nor washed away.



But since washability is not the touchstone of every drafting operation, K&E went a step further. Result – the Ruwe pencil. Having all the "fine feel" and erasibility of graphite, on both film and cloth, the Ruwe deposits a blacker, denser line than graphite, with the smudge resistance the old graphite pencil could not provide.

Here's why: the Ruwe pencil *is* graphite, but with a plastic binder instead of clay. Color coded in five degrees of hardness from 2S to 6S, Ruwe is available in wood pencils and leads. More good news is that Ruwe is now available in 2S and 3S hardnesses for fine-line automatic pencils as well. The lead is just .036" in thickness – ideal for free-hand lettering.

It's interesting to note, that since the introduction of Ruwe, other plastic-graphite pencils have been placed on the market. If you're interested in testing the original we'll send free Ruwe pencils to you – just send the coupon.

Now You See 'em...Now You Don't

For engineering drawings, or freehand sketches, K&E GUIDE LINE™ tracing papers, cloths and films make light work for you – by making light *work* for you. The light blue cross-section lines are visible to the eye, but will not reproduce on your diazos or blueprints. Other companies make similar products but here's the important K&E contribution: GUIDE LINE is now available in the widest variety of drafting media ever. Specifically: ALBANENE® and CRYSTALENE® 100% rag stock tracing papers, PHOENIX® water-resistant tracing cloth and HERCULENE® polyester base drafting film. So whichever sheet you use, odds are it's available in GUIDE LINE first.

We especially recommend GUIDE LINE products for accurately guiding freehand work such as plant layouts, organization charts, electrical diagrams, etc. Your freehand work actually will look more like a finished detail than a sketch. And confidential notes will drop out too, if written or typed in special colors.

Available in a wide variety of grid sizes, GUIDE LINE comes in rolls or pads on ALBANENE and CRYSTALENE, in rolls on PHOENIX and HERCULENE, and can be supplied with your own title block or special heading.

Send for some free samples and the GUIDE LINE brochure.

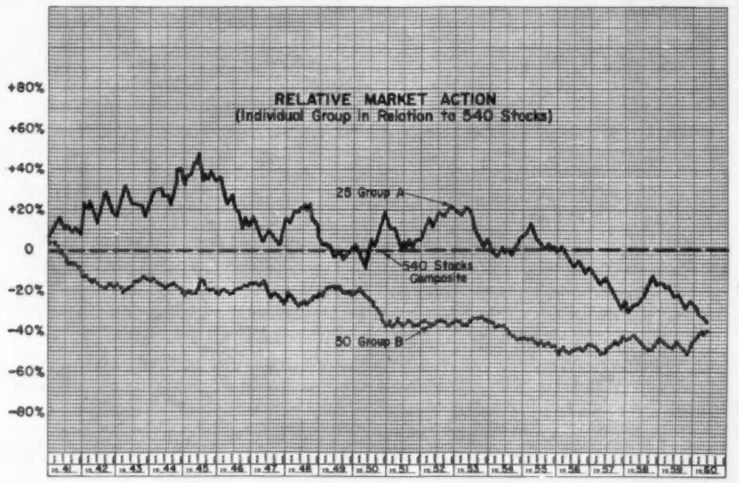
Through The Looking Glass

No more "Alice in Wonderland" wandering about when you want to locate the graph sheet you need for a specific job. Reason – K&E graph sheets now are packaged with a new "looking glass" – A time-saving *visual* package. This unique package has a window in the front so you can see the sheet inside. This is a boon, especially if you use a wide variety of graph sheets. Apart from the packaging, we've done a few other things to make graph-sheet selection easy and infallible.

Every user of graph paper puts it to a different task. So we have put together a complete line of graph papers, one or more of which will almost certainly meet your particular requirements. As a matter of fact, odds are 1000 to 1 that we already make and sell the sheet you require. In the event that we don't, we'll work with you to create it.

And we bend over backwards to make sure every sheet with the K&E symbol more than does its job. To insure accuracy of performance, every K&E graph sheet ever made was printed from precision-engraved plates by the letterpress process. The paper used – translucent or opaque – has at *least* 50% rag content – 100% in some cases. And before any of it ever gets to the printer, it undergoes extensive examination in our quality control labs.

There is a lot more we could tell you about K&E graph sheets. We have prepared a selection guide for your use. If you'd like to have one, it's free, along with some sample sheets in the new *visual* package.



12,300 variables at a glance. Here's a typical stock market chart used to study relative market action. Center line is market behavior of 540 stocks over 20-year period. Two basic stock groups of 25 and 50 individual stocks, averaged, are plotted against market (figured at zero per cent). Resultant chart shows all-important slope of curve which – far more than gross increases – tells the story of the stocks' vitality. No list of statistics, no matter how exhaustive, could give the relative interactions shown here. This picture is possible only with a graph.

KEUFFEL & ESSER CO., Dept. DN-9, Hoboken, N. J.

Please send me free:

☐ Ruwe Pencils ☐ GUIDE LINE™ Brochure and Samples

☐ Graph-paper Selection Guide and Samples

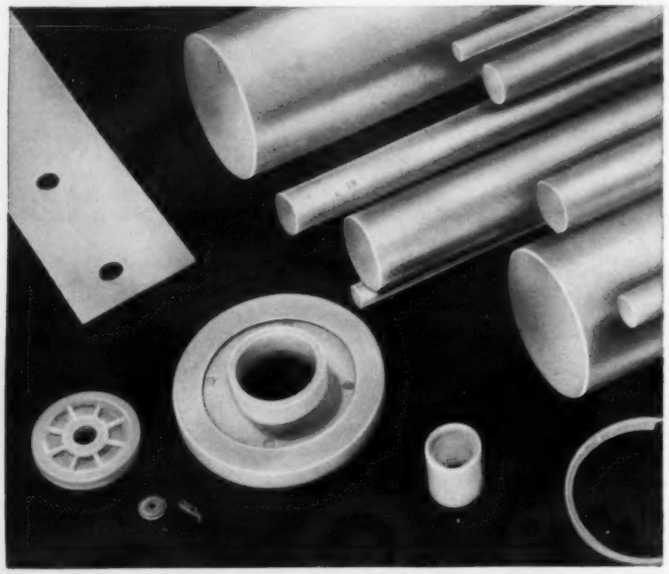
Name & Title_____

Company & Address_____

4234

Circle 28 on Reader-Service Card for more information

DELRIN
In Design
Engineering



For ready cutting and machining, Style 8701 Delrin rod is available in standard diameters 1 ¼" to 3" standard lengths 4 and 8 feet.

NEW GARLOCK DELRIN now ready to help you achieve the extraordinary in product design.

This remarkable new material opens new horizons to you for creativity, product improvement and production economy. Just look at the unique combination of properties that make Garlock Delrin* superior in many ways to metals, as well as to many other widely-used plastics.

- Metal-like strength and rigidity—high dimensional stability and fatigue endurance.
- Resilience comparable to spring steel.
- Resistance to solvents unmatched by most organic compounds.
- Abrasion resistance superior to many metals.
- Excellent electrical properties.
- Low coefficient of friction.
- Odorless, tasteless, non-toxic—pleasant, smooth to the touch.

Best of all, Garlock Delrin retains these properties through a wide range of service conditions—temperature (−40°F to +250°F), humidity, and stress.

Add, too, important Garlock "know how" . . . years of experience in the fabrication of plastics, and unsurpassed molding facilities. Result: a combination that can produce intricate shapes and custom-designed parts never before possible. Garlock design engineers can now work directly with you in creating advanced components . . . parts that replace other materials and do the job better at lower cost.

Look to Garlock as the source for all your plastic needs—Teflon* (TFE and FEP), Nylon, Polychlorotrifluoroethylene (C.T.F.E.), and many other plastic materials. For complete information on what Garlock offers in the way of materials, facilities, and technical assistance, call your local Garlock representative at the nearest of our 26 sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalog AD-177, Garlock Inc., Palmyra, N.Y.

GARLOCK

Canadian Div.: Garlock of Canada Ltd. **Plastics Div.:** United States Gasket Company. **Order from the complete line** of quality Garlock products . . . Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Stock and Parts.

*DuPont Trademark

Circle 29 on Reader-Service Card for more information

Ammonia Value Uses Ductile Iron For Greater Capacity

Lars G. Soderholm, Midwest Editor

In the redesign of a series of ammonia valves, ductile iron was used as the material of construction to achieve size-weight reductions and better shock resistance. Because thinner walls were practical, valve flow capacities generally were increased.

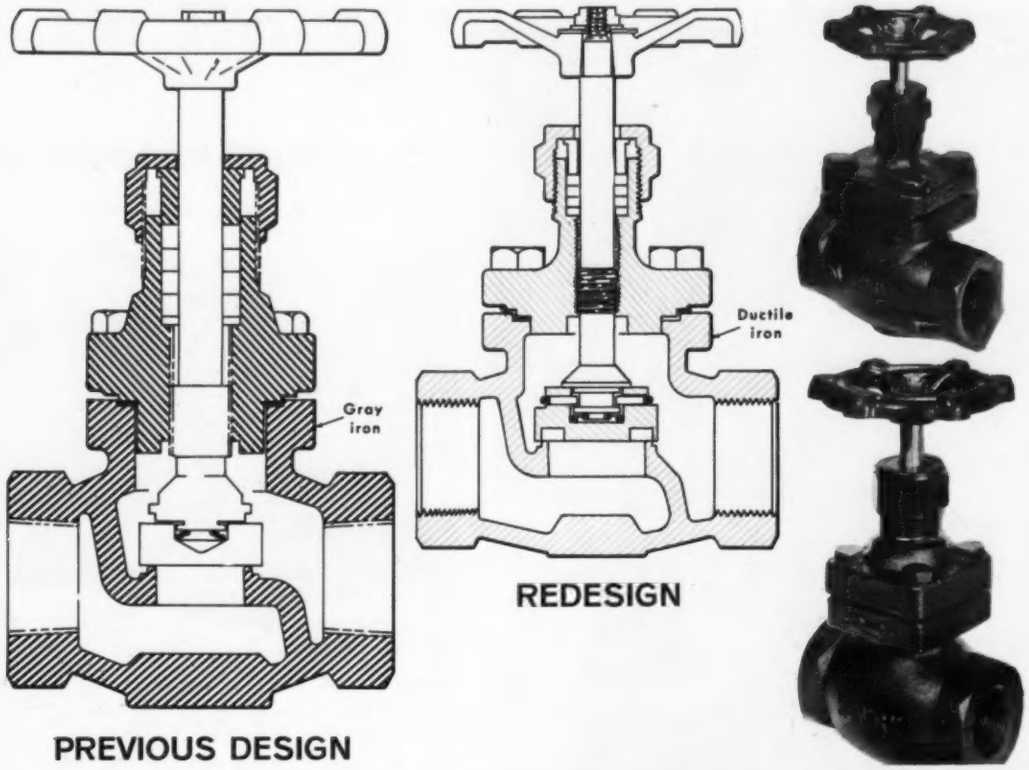
Gray iron valves, long a standard in the industry, proved to have disadvantages in some applications because of their size and weight. When a manufacturer of ammonia valves began to redesign a series of valves, this was taken into consideration as the advantages of ductile iron were weighed against those of gray iron.

Ductile iron, which contains its carbon in the form of spheroids or nodules rather than flakes, has a tensile strength of 60,000 to 80,000 psi, a yield strength of 45,000 to 60,000 psi and an elongation of 10 to 30 percent. Gray iron has its tensile and yield strength in the 30,000 to 40,000 psi range but has almost no elongation. At elevated temperatures, ductile iron shows some decrease in tensile strength but is still higher than gray iron. The modulus of elasticity and endurance limit are double that of gray iron; the Brinell hardness, wear resistance and corrosion resistance are about the same.

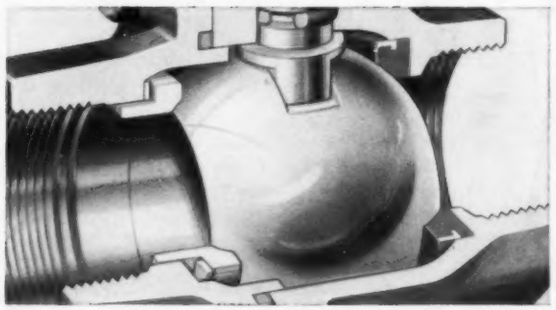
By taking advantage of the physical characteristics of ductile iron, the valve designer was able to reduce the size and weight of the valves while increasing their capacity somewhat. The redesigned valve has greater shock resistance and has a higher rated working presure.

Two types of these valves are currently available. The industrial valves have "Teflon" V-rings for stem packings for easy turning and use a nylon seat material The ammonia refrigeration valves use a conventional ring-type stem packing and a lead alloy seat disc. The refrigeration valves operates at temperatures in excess of 300F while the industrial valves operate up to 275F. Both are rated at a 400-psi working pressure. A safety factor of more than 10:1 was used in the design of these valves.

The ammonia valves are available in 1/4 to 2-1/2 inch sizes in globe and angle types. They are manufactured by the Henry Valve Co., Melrose Park, Ill.



IN ROCKWOOD BALL VALVES



waterway size counts

When ball valve waterway size is smaller than pipe size, flow is obstructed and pressure lost. That's why you should always compare *waterway sizes*. You'll find that Rockwood Ball Valves have larger waterways per valve size. And Rockwood valves are ruggedly built to seal tight and last longer — in any application.

Get complete facts from Rockwood Sprinkler Company, Ball Valve Department, 855A Harlow Street, Worcester 5, Mass. Distributors in all principal industrial areas. Rockwood Sprinkler Company, A Division of The Gamewell Company, A Subsidiary of E.W. Bliss Company.

ROCKWOOD

BALL VALVES

Circle 30 on Reader-Service Card for more information

PHILADELPHIA

THERMAL CONTROLS AND THERMOMETERS

Specify!
THE BEST
A half century of experience is back of every instrument we make. You get assured accuracy and long dependable performance when you specify "Philadelphia." Our specialized staff will be glad to discuss your problem in our field.
SEND FOR CATALOG 110
Since 1905

PHILADELPHIA THERMOMETER CO.

4401 N. Sixth St. • Philadelphia 40, Pa.

Circle 31 on Reader-Service Card for more information

FREE YOURSELF

from design limitations!

POXYLUBE, the modern solid film dry lubricant, applies like paint yet lubricates like oil. Removes the need for frequent lubrication . . . controls friction and wear . . . simplifies design . . . increases reliability on levers, springs, locks, cams, gears, and controls. You can have all these advantages and in many cases ***actually lower production cost.***

POXYLUBE bonds permanently to structural metals, metal products, plastics, wood, glass . . . requires only surface de-greasing before application . . . operates in temperatures between —100°F. and +500°F. with a coefficient of friction range of .038 to .095, is effective in thicknesses from .0001 inch.

Try POXYLUBE. Discover a new freedom in product design. Two formulas available: Poxylube 750 (Heat Cure) and Poxylube 420 (Air Dry). POXYLUBE comes in economical bulk quantities or aerosol spray cans for use in production and testing

POXYLUBE

POXYLUBE 750 (Heat Cure) : $4.25 e.
POXYLUBE 420 (Air Dry) : $3.75 e.

POXYLUBE, INC., Dept. DNf, 541 S. Webster, Indianapolis 19, Ind.

Circle 32 on Reader-Service Card for more information

ALAN
WOOD
PLATE

NOW 96" WIDE

Now—from our new wide plate mill-quality sheared plate up to 96 inches wide . . . or up to 4 inches thick . . . in lengths up to 80 feet.

A unique third stand adds improved finish and flatness to regular plate. It is also used to impress the familiar and exclusive Super Diamond pattern on floor plate, now available up to 2 inches thick.

We've added a new blooming mill, too . . . for handling bigger ingots, turning them into the heftier slabs needed to feed our plate mill's extra capacity.

These new mills are part of Alan Wood's $36-million expansion program . . . creating new and better ways to serve you. Let us supply your steel needs.

ALAN WOOD STEEL COMPANY

Conshohocken, Pa. • STEEL PRODUCERS WITH THE CUSTOMER IN MIND

Plates (Carbon, Alloy, Hi-Strength) • Cold Rolled Sheet and Strip • Hot Rolled Sheet and Strip (Carbon, Alloy, Hi-Strength) • "A. W." Super Diamond Patterned Floor Plate • "A. W." Algrip Abrasive Rolled Steel Floor Plate • "A. W." Iron Powder • "A. W." Pig Iron • Foundry and Industrial Coke • Coal Chemicals Mine Products • "Penco" Lockers, Cabinets and Shelving.

Circle 33 on Reader-Service Card for more information

Stretch-Formed Aluminum

Edward W. Schrader, Western Editor

Stretch-formed shapes improve eye appeal and safety of travel trailer The rounded corners are formed from 0.090-inch-thick, type 3003-0 aluminum. After forming and cutting, the aluminum is anodized for corrosion resistance and to match the riveted aluminum body of the trailer. All other aluminum parts on the trailer are precoated.

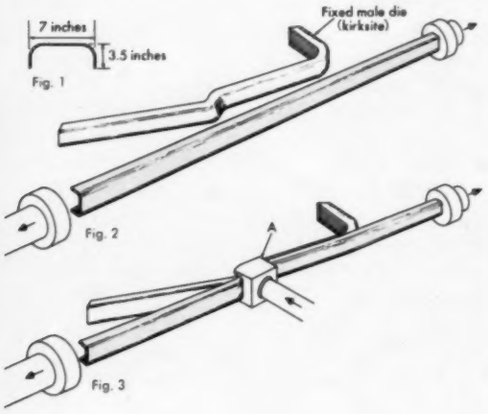
The stretch-formed corners also serve as structural members. The rounded corner blends with the wraparound window at the front of the trailer.

The trailer is a product of Boles-Aero, Inc., Burbank, Calif. Trailer design is by Industrial Design Affiliates, Beverly Hills, Calif.

VINYL PLASTIC COVERING protects forward view window from damage caused by flying rocks while trailer is in transit. In park, cover extends to make awning for window.

Adds Round Corners on Trailer

REAR STRETCH FORM FRONT STRETCH FORM



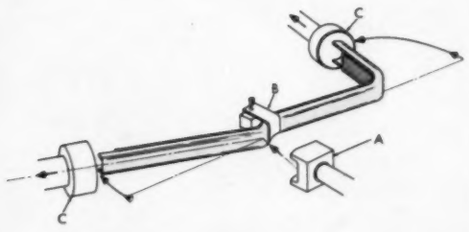
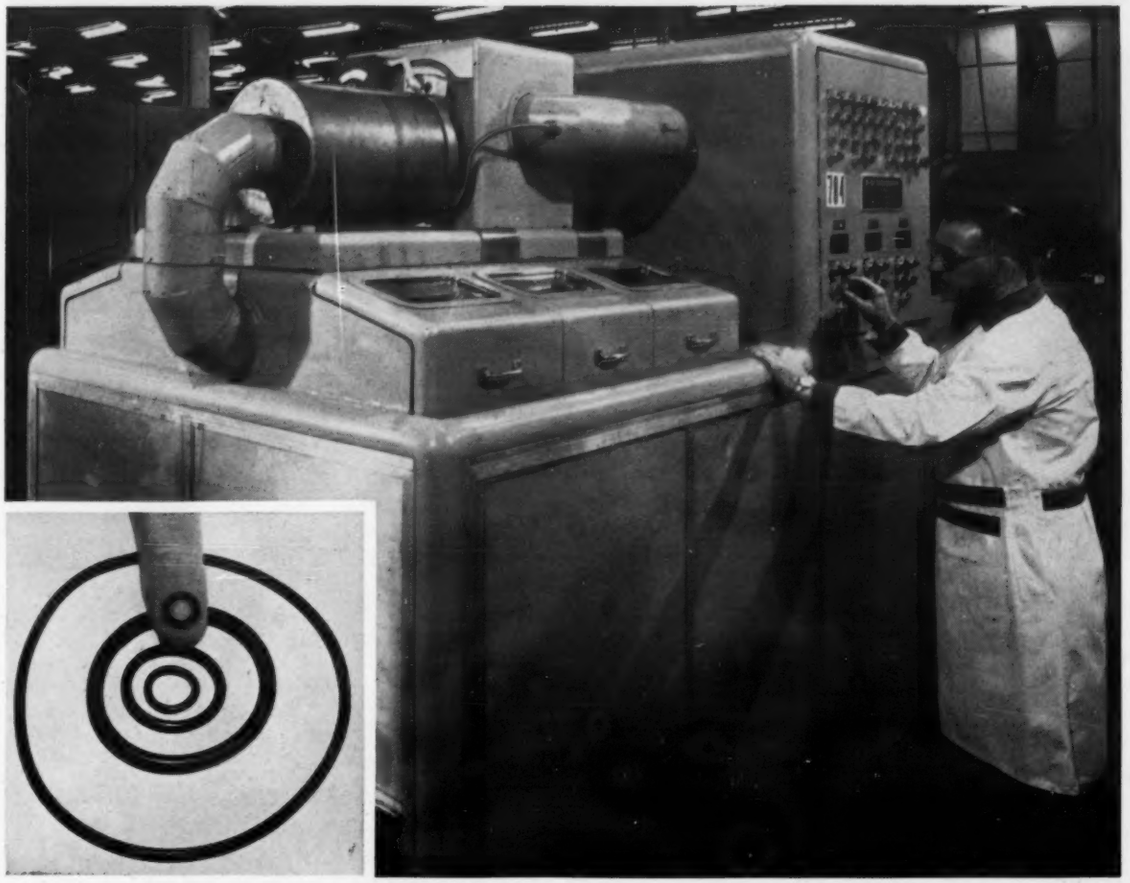


Fig. 4

STRETCH-FORMED ALUMINUM is sawed down middle to make right- and left-hand corners from one shape. Front corners are made from one piece. Rear corners are made from separate pieces. In Fig. 1, sheet of 0.090-inch-thick type 3003-0 aluminum, 12 by 144 inches, is brake-formed to shape. In Fig. 2, part then is fixed into jaws of stretch-forming machine and positioned in front of male kirksite die. In Fig. 3, concave portion of part is formed by pressure from die "A". In Fig. 4, die "A" backs off and strap "B" is placed over part to retain concave shape. Jaws "C" hold ends of part and then pivot to form remaining two curves over male die. During this operation, die "A" is used as wiper to help form curves.



This hydraulic "torture tester" used to blow its seals every few days, interrupting tests, delaying results, causing expensive maintenance. When auto producer switched to VITON seals (inset), trouble stopped.

SEALS SNAPPED LIKE PRETZELS...

until VITON® O-rings were installed in this hydraulic hose tester

In the lab of a major auto producer, this pressure-impulse machine pounds power-steering hose with 1500 psi surges of hydraulic fluid at 325°F. at the rate of 600 cycles a minute—hour after hour.

Formerly, many kinds of good oil-resistant seals baked out, leaked badly—sometimes within a few days; actually were too brittle to be removed intact. But now, VITON O-rings go for months without losing their resiliency or stability. They are replaced only on routine overhauls.

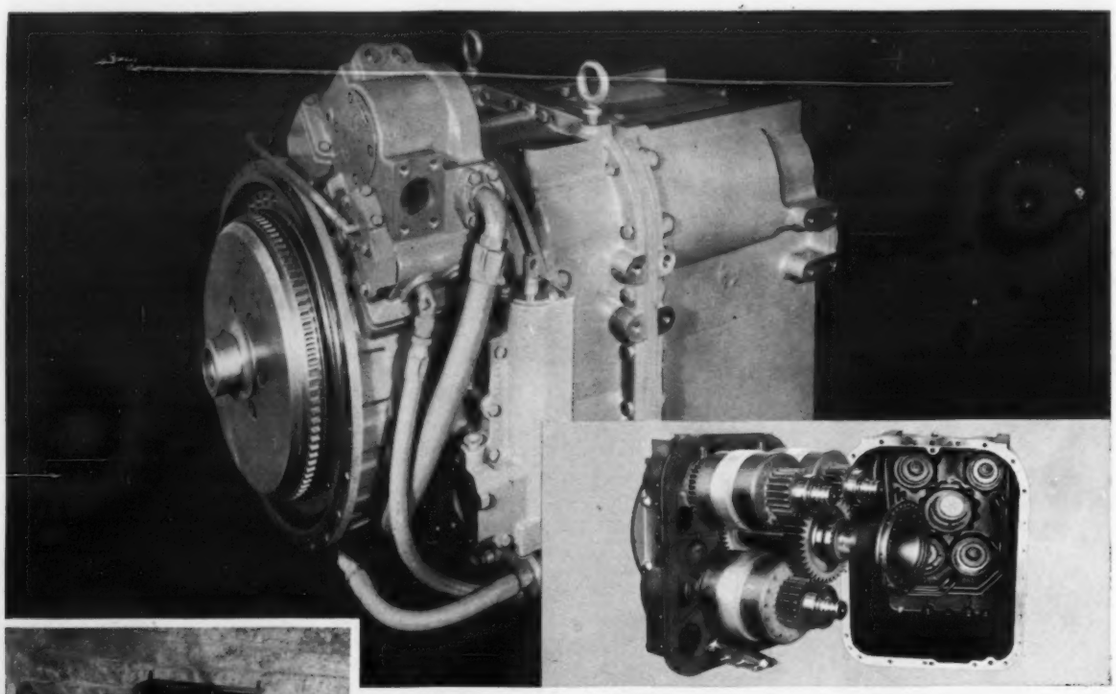
Frequently, as in this case, VITON is the only synthetic rubber that can perform dependably in environments combining high heat with fuels, lubricants or hydraulic fluids. That's why VITON is solving more and more design problems in critical seals, gaskets, diaphragms, hose tubes, valve parts and couplings. Contact your rubber supplier for more information, or write: E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department DN-9, Wilmington 98, Delaware.

DU PONT REG. U. S. PAT. OFF.

VITON®
SYNTHETIC RUBBER

Better Things for Better Living . . . *through Chemistry*

Circle 34 on Reader-Service Card for more information



TEST REPORT on Twin Disc's New Power-Shift Transmission

Series TA-51-2000, designed for vehicles

- Three models with ratio spreads of 5.45, 5.93 and 6.80.
- Capacities: 420 hp; 1050 lb/ft torque.
- Straight-through countershaft design with constant-mesh gearing.
- Five forward speeds; one reverse.
- Full power-shift in all ranges through oil-actuated clutches.
- Engineered as package unit with Twin Disc Single-Stage Torque Converter.
- Converter has lock-up clutch on front end to provide direct drive performance when desired.
- Hydraulic retarder saves wear on brakes . . . permits safe, controlled descents at higher speeds.

Assignment: Hauling copper ore at Arizona mine

At the open pit copper mine of Inspiration Consolidated Company, Inspiration, Arizona, 22 dump trucks work around the clock, seven days a week, to haul out 105,000 tons of ore and 75,000 tons of waste rock. As a test of vehicle endurance, this is about as grueling an operation as you could find anywhere. It was here that Twin Disc's new Series TA-51-2000 Power-Shift Transmission was asked to prove itself.

For testing purposes the transmission was installed in Truck No. 62, a 40-ton Dart 37SL Dump Truck powered with a Cummins NVH-1200 Diesel. This engine produces about 420 net hp (2100 rpm) at the flywheel.

Along with the other 21 trucks in the Inspiration fleet, Truck No. 62 was put to work on the three-mile haul road between pit and crusher.

Result: Six more transmissions ordered

In six months on the job the Twin Disc transmission proved its worth. Regarding its performance, T. M. Anderson, Open Pit Foreman for Inspiration, had this to say:

"On the basis of cycle times, fuel efficiency and shifting ease, No. 62 has been beating them all since we put in that new power-shift transmission. The truck pulls away from the loading shovel in third converter drive and is already in fifth lock-up drive when it hits the grade."

As a result of the test model's outstanding performance, Inspiration has already ordered six more Twin Disc Series TA-51-2000 Transmissions.

Twin Disc engineers will be pleased to make application recommendations for your vehicle drive.

ENGINE TO AXLE WITH... TWIN DISC

TWIN DISC CLUTCH COMPANY, Racine, Wis. (Hydraulic Division) Rockford, Ill.

Circle 35 on Reader-Service Card for more information

Molded 'Lexan' Modules

Lars G. Soderholm, Midwest Editor

A series of lighted pushbutton switches is able to provide good light distribution and color intensity through the use of molded plastic modules. Each bulb module holds several contoured colored filters that project a display on the indicator screen. The target module holds the indicator screen and transmits pushbutton movement to the mechanism that actuates the double-pole subminiature switch (DESIGN NEWS, FEB. 1, 1960).

An efficient optical display system in compact form became practical when it was found that molded "Lexan" (General Electric Co.) modules could be made economically in sections as small as 0.020 inch thick and held to tolerances of ± 0.005 inch or less. This material, in addition to its good electrical characteristics, has extremely low water absorption, high thermal stability (to 275F) and enough strength to resist cold flow.

The "Lexan" bulb module holds four bulbs in rectangular molded sections, each with its own acrylic colored filter. Lighted pushbuttons of this type normally display two colors, one at a time.

Light passing through the filters is projected on the acrylic screen cemented onto the molded "Lexan" target module. The target module is in the shape of a rectangle with vanes projecting from each wall to hold a center operating post.

The switch is actuated by pressing the target screen. This force is transmitted through the modules to the center post that engages a switch actuating rod. A nylon cam and pinion assembly permits the switch contacts to be alternately opened and closed.

This is done through a four-lobed cam that holds the switch closed when a lobe is against it and lets it remain open when the lobe is in an in-between position. An eight-tooth pinion, advanced by a projection from the actuating rod, provides the cam positions necessary for proper operation.

One of the new switches can be used in situations that called for up to four individual lights and switches in the older design. Each of the switches can control two 5-amp circuits (30v d-c), two 10-amp circuits (125/250 amp a-c) or a single 10-amp, 30v d-c circuit.

The 04 series lighted pushbutton switches are manufactured by the Licon Div. of Illinois Tool Works, Chicago, Ill.

Circle 36 on Reader-Service Card

Hamilton

DRAFTING EQUIPMENT

actually pays for itself

in increased efficiency

*and savings in floor space**

**Ask [illegible] the interesting Hamilton "INCREASED EFFICIENCY KIT." It will open your eyes to new drafting room economies.*

Pat. Pending

EXCLUSIVE TORSION BAR MECHANISM
permits effortless fingertip board-tilt adjustment. Counterbalance compensates for weight added to board by drafting machines, lamps.

NEW Torsion AUTO-SHIFT Drafting Table

This new Hamilton drafting table combines truly imaginative engineering with an intimate knowledge of *today's* drafting procedures. It offers exclusive "freedom from fatigue" features, plus a new design that can provide space economies of up to 47%. Investigate the EXTRA/EFFICIENCY *only* Hamilton delivers!

Hamilton Manufacturing Company, Two Rivers, Wisconsin

COMPLETE FILE-REFERENCE FLEXIBILITY
File-reference facilities may be installed for use at either side of table—to fit any layout, tailoring the *table* to the *draftsman, not* the draftsman to the table.

Hamilton brings

EXTRA / EFFICIENCY

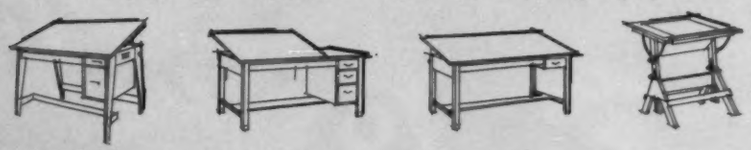
to your drafting facilities
through planned layout and
superior equipment performance

UNIT SYSTEM FILES
Maximum protection and storage capacity in minimum space. Each shallow drawer has an exclusive tracing lift mechanism so that every tracing becomes a top sheet, instantly accessible. Unit files stack in the arrangement that fits *your* needs and can be added to as your requirements grow.

NEW MODUCOR FILES
Smart, modern, practical—MODUCOR is the better way to file roll tracings in limited space, with a minimum investment. Three different tube sizes, with spring-activated doors, and label holders. Standard module construction permits integration with other Hamilton file units.

L-CONTOUR DRAFTING TABLE
A personalized work area unit for your top-level designer-engineer draftsmen. Completely flexible counterbalanced board combines with personal right- or left-hand reference and storage facilities to give you maximum efficiency and productivity.

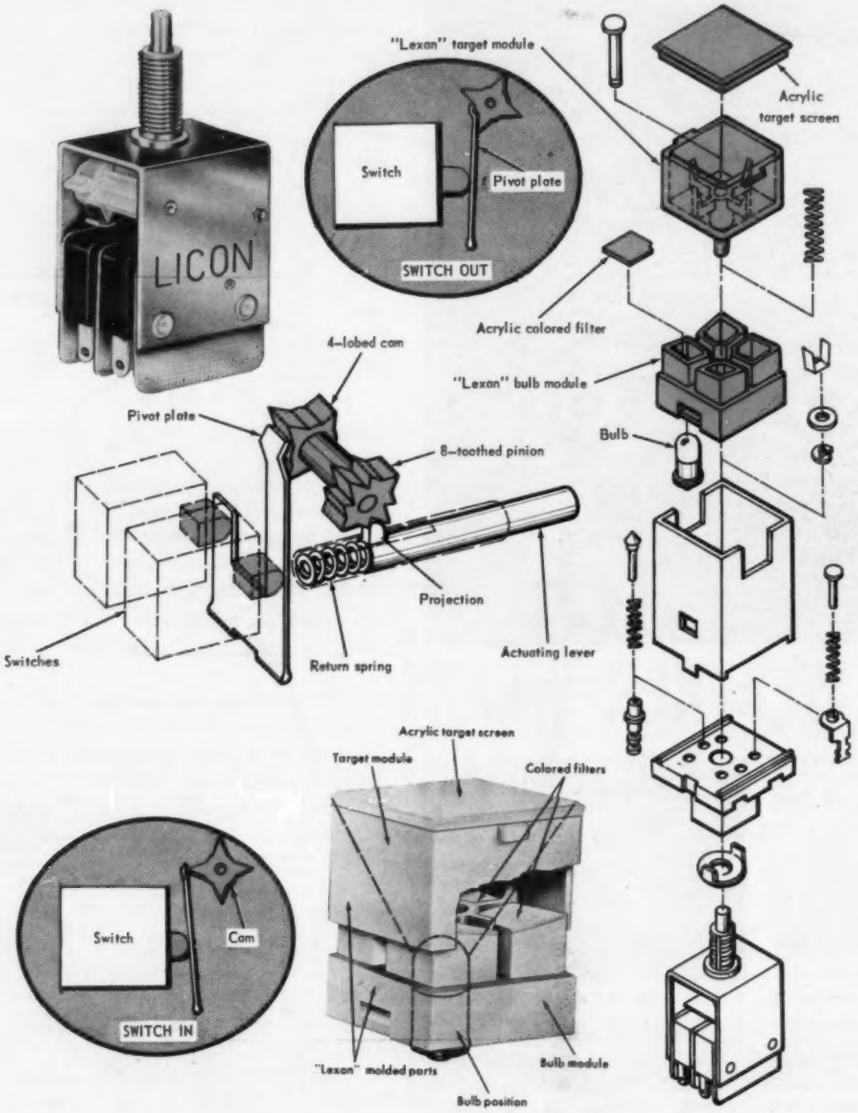
Other Hamilton *EXTRA EFFICIENCY* Drafting Equipment...



CL-100 Tables | Steelwood Drafting Tables | Four Post Drafting Tables | Tracing Tables

Hamilton
Manufacturing Company
Two Rivers, Wisconsin

Improve Display on Lighted Pushbutton Switch



For Free Reprints of the Above Article, Circle 526 on Reader-Service Card

new miniature

SYNCHRONOUS MOTOR

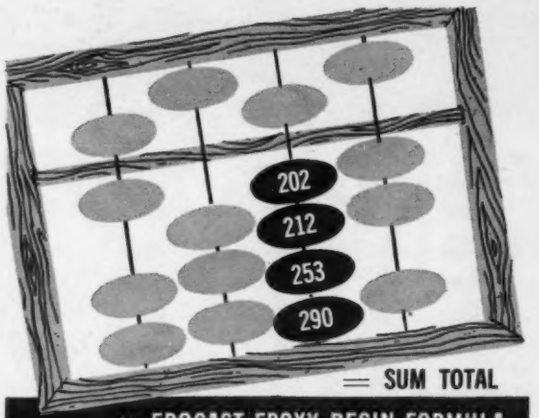
For the first time you can obtain the power-packed performance of a military precision synchronous a.c. motor at commercial motor prices. This may be just the motor you're looking for to miniaturize your design while enhancing the performance of your high quality product — recorder, business machine, timer, or other motorized device.

Quick specs: Type CMC motor has a starting and running torque of .7 oz. in. at 1800 rpm. synchronous speed. Wound for 115 v.a.c., 60 cycles, it uses 12 watts. It is 1¼" in diameter by 2¾" long, weighs 7½ ounces. Shaft is precision ground stainless steel supported by life-lubed ball bearings. Epoxy sealed design provides good resistance to normal environmental conditions. Please request Bulletin CMC-2. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

1¼" x 2¾"

GLOBE INDUSTRIES, INC.

Circle 37 on Reader-Service Card for more information



an EPOCAST EPOXY RESIN FORMULA for any ELECTRICAL INSULATION PROBLEM!

More than 30 different formulas are now in stock to solve your electrical insulation problems. Whether it be an extreme environmental condition or a normal impregnation, encapsulation or coating project, there's a Furane epoxy resin to fit your requirements.

WRITE NOW FOR FREE ELECTRICAL PROPERTIES CHART!

furane plastics INCORPORATED

WEST COAST/4516 Brazil Street, Los Angeles, California CHapman 5-1151
EAST COAST/42 Chasner Street, Hempstead, Long Island, N.Y., IVanhoe 3-6246

Circle 38 on Reader-Service Card for more information

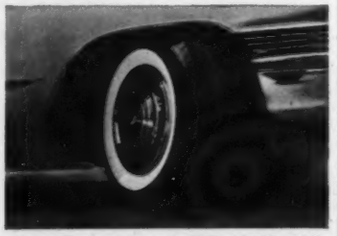
What's News in Rubber...

ENJAY BUTYL BEATS HEAT–WEATHER–WEAR

Continuous contact with materials as hot as 350°F (as in this conveyor belt) presents no problem to Enjay Butyl HT 10-66 when properly compounded for heat resistance. Actual service shows that other grades of Enjay Butyl also have exceptional resistance to high-temperature aging in ordinary atmospheres, oxygen or super-heated steam.

For application data, or for technical assistance in applying Butyl, write to Enjay, 15 West 51st Street, New York 19, New York.

Lightweight, durable, permanently flexible and applied cold, this colorful new roofing system at Longway Planetarium in Flint, Mich., takes full advantage of the unusual flexibility and non-hardening properties of Enjay Butyl.



New Enjay Butyl HT 10-66 adds toughness to air-holding innerliners which help assure correct inflation pressure on tubeless tires; gives greater blowout protection and improved tire-tread wear. Also used for sidewalls and chafer strips.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY

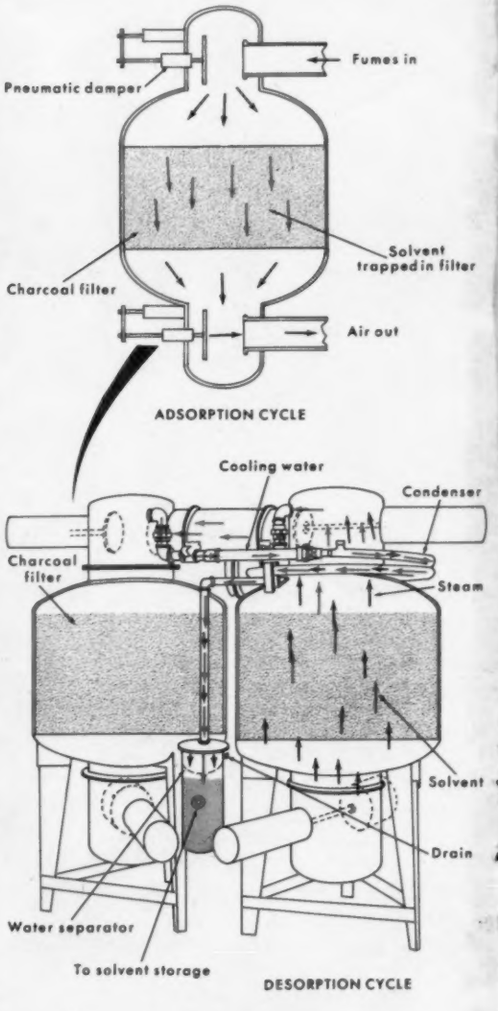
Circle 39 on Reader-Service Card for more information

Activated Carbon System Permits

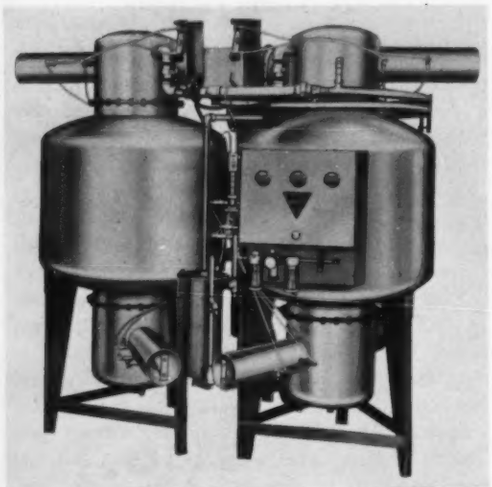
Lars G. Soderholm, Midwest Editor

A vapor-recovery system takes vapor-laden air from industrial degreasing or cleaning operations and passes it through an especially prepared activated carbon bed to remove the solvent otherwise lost through evaporation. At predetermined intervals, steam is passed through the carbon bed to carry the vapors to a condenser and a water separator from which the solvent is recovered and returned to storage tanks.

The new solvent vapor-recovery system is designed to permit high air flows for better ventilation. The system recovers nearly all the solvent



Volatile Solvent Recovery



carried out through evaporation and returns it to the system for reuse without any loss in efficiency of the recovered solvent.

In operation a fan in the ventilation duct directs the solvent fumes through a bed of carbon in the recovery unit. The carbon adsorbs the solvent while the air passes through and out of the vessel. When the carbon bed approaches saturation it must be desorbed by removing the solvent it holds.

This is done manually or automatically by closing off the inlet and outlet ducts and directing steam into the bottom portion of the unit. The steam carries off the solvent vapors which rise to the top of the recovery unit and pass into a water-cooled condenser. Here the fumes and the steam become a liquid which is separated automatically by the machine. The solvent is separated from the water and each is channeled out of the system—the waste water to the drain and the solvent to the solvent storage tank.

This system can handle all chlorinated or fluorinated hydrocarbons which include the commonly used trichlorethylene and perchlorethylene. It has proved practical for users of as little as 600 gal of solvent per year. Multiple units can be provided for greater volume capacity.

The patented "package-type" Vic Vapor Recovery Systems come in capacities of 700, 800, 1300, 1700, 3000, 3800-5500 and 7500 cfm in single units and double units. They are manufactured by the Vic Mfg. Co., Minneapolis, Minn.

Here's a new economical high-strength copper-nickel-iron alloy from

ANACONDA

Cupro Nickel, 30%-707 . . . is Anaconda's answer to design needs for an economical copper-nickel-iron alloy with mechanical properties to match those of more expensive metals. This high-strength, corrosion-resistant alloy is the product of an intensive three year metallurgical research and development program at Anaconda.

Cupro Nickel, 30%-707 . . . was especially designed for heat exchanger tubes in power station feedwater heaters. In this application, it provides performance as well as cost advantages. Typical test results show room temperature tensile strengths of 84,700 psi (⅝-inch O.D. tubes with 0.049-inch wall) and 88,000 psi (¾-inch O.D. tubes with 0.049-inch wall).

Cupro Nickel, 30%-707 . . . is finished with a special stabilizing anneal to permit tight U-bends and strength retention at elevated temperatures. The material can withstand a working stress in tension of 15,200 psi at 600 deg. F. In addition, it has high resistance to stress-corrosion cracking and excellent resistance to corrosion by sea water at relatively high velocities.

Cupro Nickel, 30%-707 . . . is adaptable to diversified design requirements. It can be cold worked and welded, used in tube sheets or for bolts and screws. It may be the alloy you need for engineering designs requiring strength, ductility, and corrosion resistance. Mechanical properties are competitive with "premium" high-strength alloy materials; cost is substantially lower. Complete details on high-strength Alloy 707, including a point-by-point comparison, are available in Anaconda Publication B-45. Write for your copy today. Address: Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

61-805

ANACONDA®
AMERICAN BRASS COMPANY

Circle 40 on Reader-Service Card for more information

Friction-Bonded Cast-Iron Ring

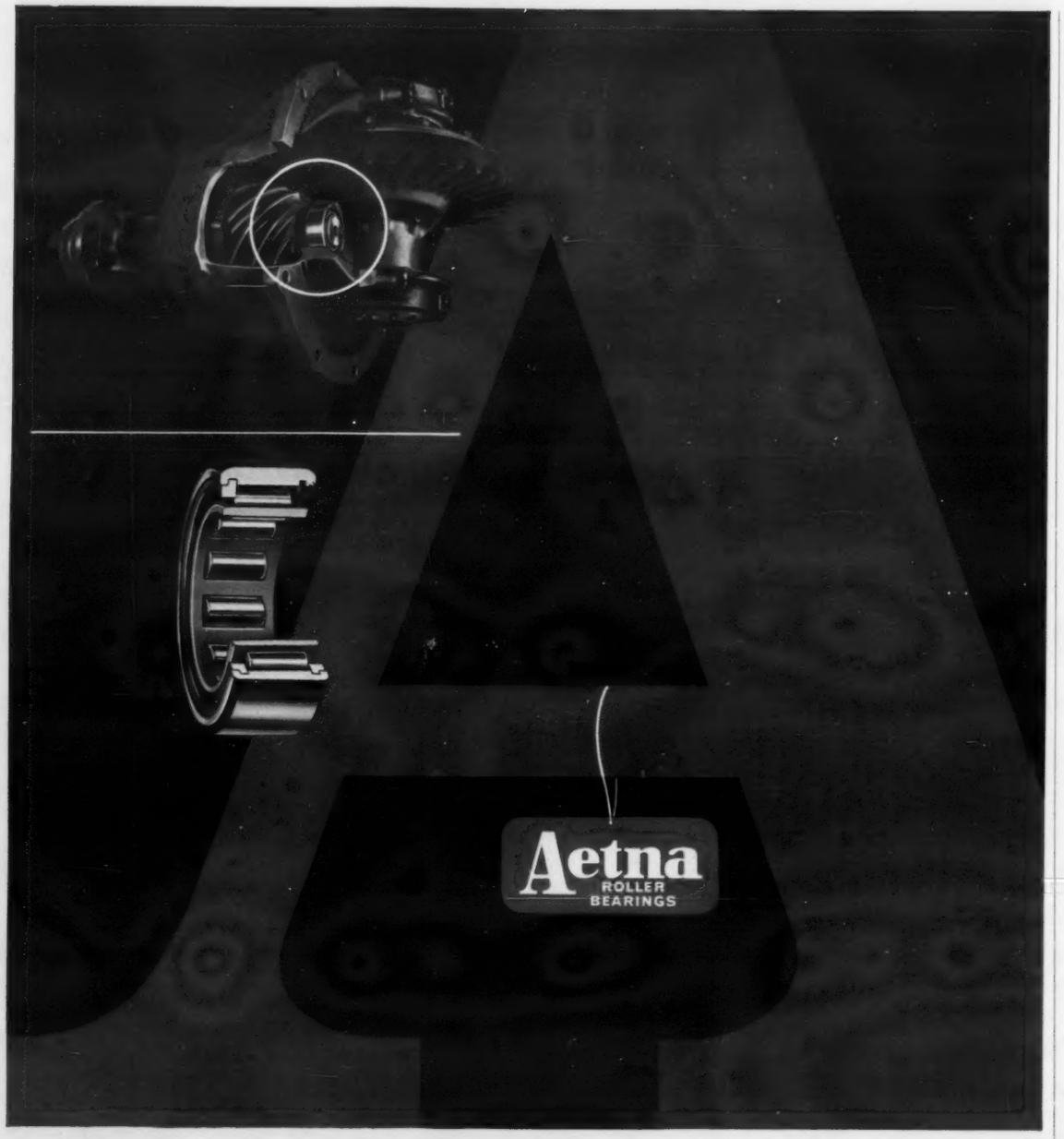
Victor W. Wigotsky, Eastern Editor

A heavy-duty cast-iron ring, with continuously bonded high-friction resilient material, is used in a double-acting cone-type clutch. Design provides higher torque capacity through increased rigidity and dimensional accuracy.

The clutch bands are used in two planetary gear train assemblies of a utility tractor. Previous clutch consisted of a flat, rolled and welded strip-steel ring and internally bonded bevel-shaped segments of molded asbestos friction material. However, difficulty of machining the ring to exact dimensions and a small percentage of ring distortion under production handling and frequent intermittent loading at full engine torque at times prevented complete contact with mating surfaces. Also, since the friction material was bonded to the ring in segments, power transmission during clutch engagement was not always uniform.

The solution is a gray iron wedge-shaped casting with a bonded high-friction resilient lining. The clutch ring now has sufficient rigidity to eliminate the problems of distortion in production handling, while the resilience of the friction material further assures continuous and uniform contact during operation. The combination has resulted in elimination of field failures.

The new clutch is used in the utility tractor manufactured by Gravely Tractors, Div. of Studebaker-Packard, Inc., Dunbar, W. Va. The R-3672-3 friction material was developed by Raybestos-Manhattan, Inc., Equipment Sales Div., Bridgeport, Conn.



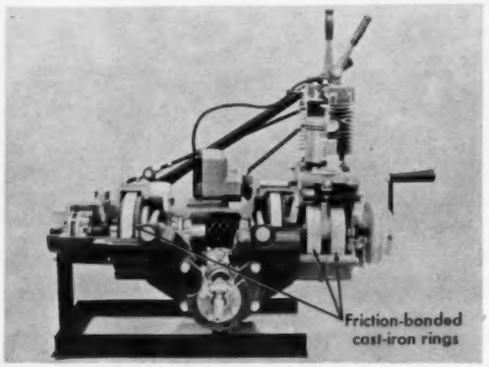
FOR FORD . . . QUALITY, THAT'S ALL For many years, Aetna bearings have been a part of Ford cars and trucks, helping to maintain their high standards of efficiency. In many Fords, Aetna roller bearings are a vital component in the differential. Clutch release bearings by Aetna also assure smooth transfer from low to high speeds. Apply this same anti-friction efficiency and quality to your product. Aetna bearings are available in a wide range of sizes in both roller and ball types, plus many special designs in both pure radial and pure thrust. For details, call your Aetna representative listed in your telephone directory or write for General Catalog and Engineering Manual.

AETNA BALL and ROLLER BEARING COMPANY | 4600 SCHUBERT AVE.
DIVISION OF PARKERSBURG-AETNA CORPORATION | CHICAGO 39, ILL.

ANTI-FRICTION SUPPLIERS TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916

Circle 41 on Reader-Service Card for more information

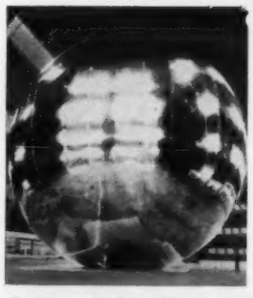
Eliminates Field Failures



ONE DOUBLE-ACTING PLANETARY GEAR TRAIN and cone-type clutch act as speed selector. Another set provides forward and reverse motion. Ring moves axially when tractor's control levers engage and disengage cone faces. In previous design, engagement gaps resulted from slight change in diameter of steel ring, causing possible failure under heavy-duty applications. In addition, it was necessary to separately weld heavy lugs to band. Bonding bevel-shaped friction material inside ring in segments, rather than continuously, also contributed to uneven pressures, resulting in variable torque effort. In new clutch-band assembly, use of heavy gray cast-iron ring, containing integral lugs, assures rigidity and strength for high torque operation. Resilient friction material, continuously bonded to cone faces, assures contact over entire 360 deg of bevel face.

UTILITY TRACTOR powers 30 different attachments and is designed to transmit 80 percent of power to operate attachments and 20 percent to wheels. When attachments are not under load, all power is transmitted to tractor wheels.

Tough, durable Mylar® cuts costs... improves product performance



1. Huge (100 ft. diam.) inflatable satellite of metalized "Mylar" stays strong and flexible in sub-zero outer space.

2. Permanent collar stays of "Mylar" last the life of the shirt... keep their shape even after hundreds of launderings.

3. Capacitors with insulation of "Mylar" give long-lasting reliability... need for costly encapsulation is eliminated.

For example, "Mylar"* polyester film gives many products extra resistance to heat, cold and aging... lengthens their life. Today, "Mylar", with its resistance to chemicals and moisture, is improving the performance of products as different as surgical bandages and intercontinental ballistic missiles.

Can this unique plastic film and products made with it help you? For more information on "Mylar", write the Du Pont Co., Film Dept., Room S-8, Wilmington 98, Del.

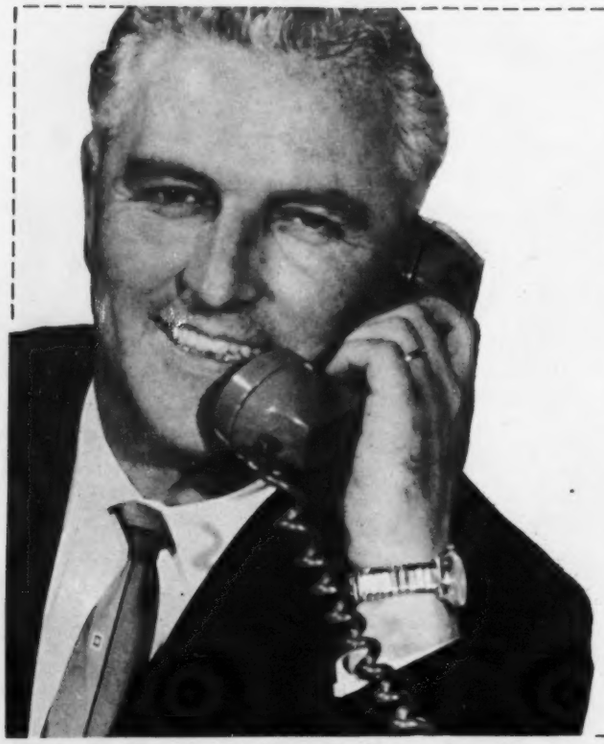
DU PONT
REG. U.S. PAT. OFF.

*"Mylar" is Du Pont's registered trademark for its brand of polyester film.

Better Things for Better Living... *through Chemistry*

DU PONT MYLAR® POLYESTER FILM

Circle 42 on Reader-Service Card for more information



CALL

MELETRON

FOR ANY TYPE

OR SIZE

OF PRESSURE

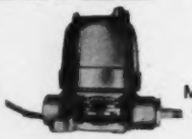
ACTUATED

SWITCHES

"When I need a pressure switch I know I can find exactly what I need from the Meletron line. I don't have to hunt for it or accept a substitute. And I can get it right away – from stock. ■ *I use Meletron* diaphragm switches *for vacuum and low-pressure applications, and the* bourdon tube switches *for high pressures (up to 15,000 psi). They respond to absolute, gauge, or differential pressures and may be* single setting, pressure difference *or* dual control *depending on the application. Reset may be either* automatic *or* manual.

Model 402

Model 420



Model 920

Model 372

Model 302

Model 1100

"Accuracy is within 2% of the adjustable range. ■ *Meletron Pressure Switches* operate at any altitude *and are* resistant to corrosion, vibration, shock, acceleration, extreme temperatures *and environmental conditions that affect other pressure sensing devices. I can also get them with a choice of housings – for* exposed mountings, explosion-proof, *or* stripped *for internal or protected mounting."* ■ *Meletron has been making pressure switches since 1940 for aircraft and industrial service and is the world's foremost manufacturer of pressure sensing devices. Write for catalog.*

MELETRON CORPORATION

950 North Highland Avenue • Los Angeles 38, California • HOllywood 3-4841

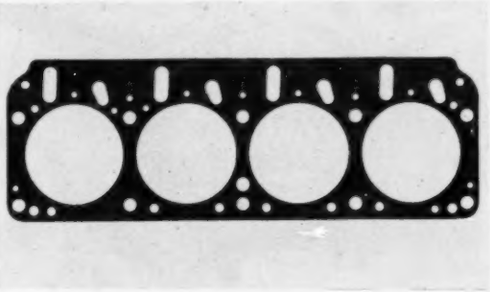
Circle 43 on Reader-Service Card for more information

Miniature Dimples

Lars G. Soderholm, Midwest Editor

A gasket material designed for high-pressure, high-temperature applications uses a light-gage metal core with 800 projections per inch on both faces. These projections serve to lock in place the gasket material covering the metal core to prevent lateral flow under load.

The demand is always for better gaskets to resist high pressures, high temperatures and to seal narrow sections. One manufacturer's answer to these demands is a gasket having a center metal core and a compressible gasket material on each side. In order to permit the metal to give strength to the gasket material, the core has 400 tiny projections per sq in on each surface. In



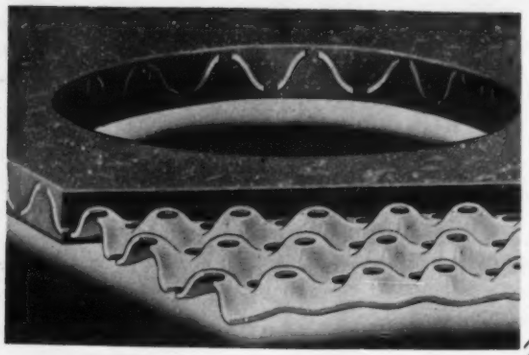
this manner great resistance to flow is obtained and only vertical movement of the gasket is permitted. There is equally good resistance against shear forces.

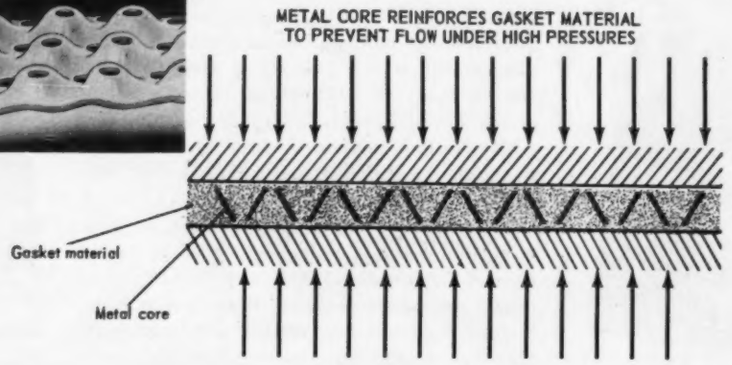
With light clamping, the metal core is never in contact with the face of the parts being sealed. With a heavy clamping force, it is possible that actual contact with the core metal could be made. Under both conditions, improved thermal conductivity is obtained through the gasket because of the presence of the core material.

This method of reinforcing gaskets offers a great deal of versatility and a large application range. The thickness of the metal core and the number of cores used per gasket (lamination) can vary with the application. The gasket material also can vary from the standard asbestos with a synthetic rubber binder to silicone, "Teflon", "Viton" or similar materials.

The Victocor gasket material was developed by the Victor Mfg. & Gasket Co., Chicago, Ill.

Lock Gasket Material to Metal Core





PRECISION PLASTIC BALLS

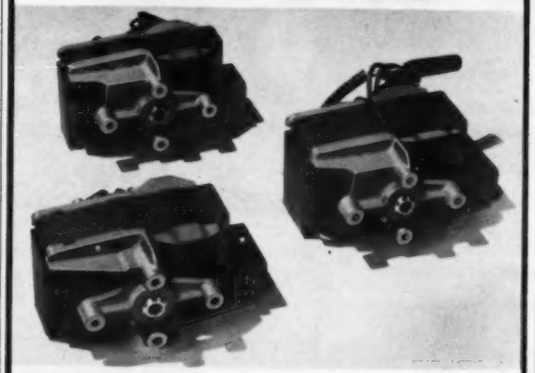
ACE is one of America's leading mass producers of seamless plastic balls for almost every commercial and industrial use. Most plastics including **nylon** and **teflon**. Complete range of sizes, colors and tolerances. Small runs or large runs. Huge stocks for immediate delivery. Quick, low-cost service on specials. Write, wire or call for samples, price lists and handy new selection chart.

SINCE 1931 A EXTRUDERS FABRICATORS

ACE PLASTIC COMPANY 91-26 VAN WYCK EXPWY · JAMAICA 35, N. Y.

Circle 44 on Reader-Service Card for more information

ELECTRIC VIBRATORY MOTORS



These three standard Syncro units deliver up to ¼" amplitude at 14,400 strokes per minute. They're rated at 4, 3 and 2 amps full load at 115 vac. All feature a multiple torsion bar pivot bearing with no wear surfaces. Their sophisticated, trouble-free design has gained wide acceptance on sanders, saws, polishers, coin sorters, slicers—even peanut butter spreaders. Why not test them on your vibrating power problem?

SYNCRO
CORPORATION
OXFORD, MICHIGAN

Circle 45 on Reader-Service Card for more information

NEW OPENING

Offering Unusual Career Potential

PUMP DESIGN ENGINEER

. . . over $10,000 salary bracket

One of the nation's leading manufacturers of products for the industrial, consumer and defense markets has a recently created position for an experienced centrifugal Pump Design Engineer. This position offers outstanding personal as well as professional potential with a company not now engaged in the manufacture of pumps, but of advanced systems in which pumps—(10 to 1500 hydraulic h.p. range)—are incorporated.

RESPONSIBILITIES

You will assume full technical responsibility for pump design and development, and for providing pump application data on these designs. You will also provide consulting services to engineers designing the systems in which your pumps will be used.

QUALIFICATIONS

BSME together with an MS (or the equivalent in experience). Minimum experience requirements include 5 to 10 years with a pump manufacturer—preferably in fluid mechanics and/or centrifugal pump design. You must also be able to meet and favorably impress our customers.

Location is in the Northeast. You will have full access to computers, extensive testing facilities, consultants and laboratories.

Qualified applicants will be invited to visit our facilities at Company expense. Relocation assistance will be provided. Additional information about our extensive benefits program for employees and dependents will be provided.

Please include enough information about your education and experience to justify further consideration for a position of this salary and responsibility level. All qualified applicants will be considered for employment without regard to race, creed, color or national origin. SJ-549

FOR MORE INFORMATION, write in confidence to:
DESIGN NEWS
60 EAST 42ND STREET, NEW YORK 18, NEW YORK

NEW IDEAS ON ROLLER CHAIN

TO IMPROVE YOUR PRODUCTS... SAVE YOU MONEY

COMPLETE DESIGN IDEA KIT AVAILABLE WITHOUT COST

Want new ideas on how roller chain can help improve your product's design? New application of roller chain to stimulate design ideas? Then here's a gold mine of new applications—the Atlas Design Idea kit.

It is free for the asking. File folder format includes nineteen completely new ways to use roller chain... shown in blueprint form. Shows roller chain as slat conveyor, reciprocating drive, feed roll drive, internal gears, external gears, flexible shaft coupling, rack and pinion table feed, lever actuator and many others.

Write today for your chain idea folder. Another step ahead by Atlas to offer improved products and increase the efficiency of the use of roller chain. Write...

ATLAS CHAIN & MANUFACTURING COMPANY
Subsidiary Prudential Industries
West Pittston, Pa.

ATLAS
PRUDENTIAL INDUSTRIES
ATLAS

Circle 46 on Reader-Service Card for more information

PATENTS

Pipe Joint

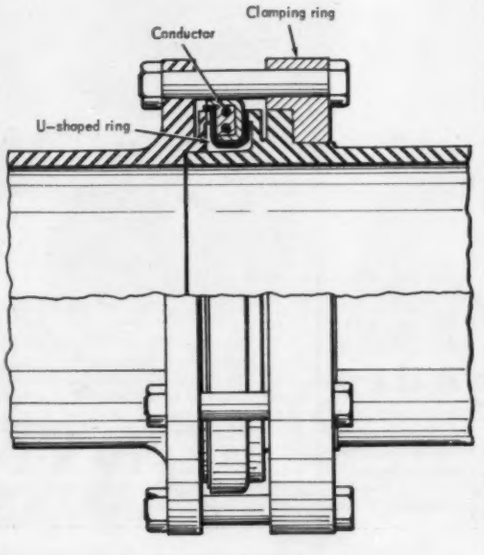
U. S. Patent 2,992,838; Rudolf N. Wallace, Glastonbury, Conn., assignor to United Aircraft Corp., East Hartford, Conn.

The mechanical connection of this pipe joint is sealed by a thermoplastic material. A means is provided for heating the material to make or break the seal. The sealing member is flexibly mounted so that creep or yield in the connection will not break the seal.

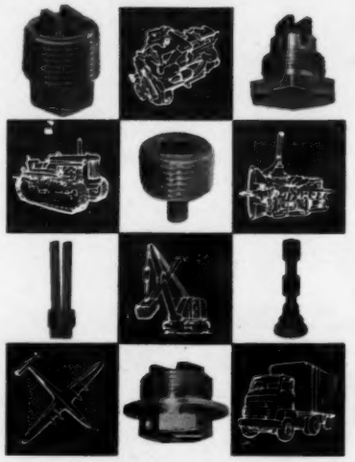
One end of the joint has an annular recess which serves to pilot the mating end of the second pipe. Bottom of the recess forms an abutment to limit engagement of the two pipes. An outstanding annular flange on the first pipe contains a series of holes which match holes in a clamping ring.

The sealing method consists of an annular flange on the first pipe, to which is welded a resilient U-shaped ring. The other end of the U-shaped ring contains a flange which serves to guide the ring and to locate an annular strip of thermoplastic material. The strip may be, for example, a brazing compound. A means is provided to heat the thermoplastic strip and provide the seal. Two heating wires are embedded in electrical insulating material within the U-shaped ring. When current passes through the conductors, the strip is softened and a permanent fluid-type bond is provided.

To break the joint, the retaining bolts are removed and current is applied to the conductors to soften the material.



WORTH TESTING IN YOUR PRODUCT



LISLE *Magnetic* PLUGS

If your product has moving parts operating in a fluid, a test will prove that you can reduce costly wear with Lisle Magnetic Plugs.

Ferrous metal particles in a lubricant are a major cause of wear. The Lisle Magnetic Plug removes these abrasive particles — eliminates unnecessary wear.

See for yourself. Try Lisle Magnetic Plugs in place of the ordinary drain or fill plug in your product.

FREE *Samples for Testing in Your Product!*

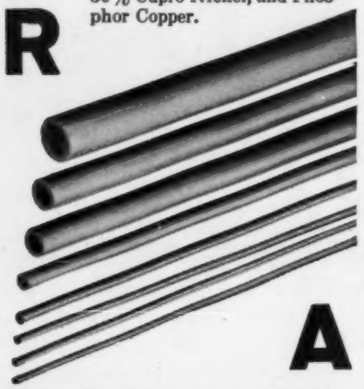
LISLE CORPORATION
Clarinda, Iowa

Circle 47 on Reader-Service Card

Fine Seamless TUBING in COPPER ALLOYS

When product design requires small (down to 0.005″ O.D.) seamless tubing drawn in copper alloys to extremely close tolerances, your best source of supply is UNIFORM TUBES. With skill and craftsmanship, this specialty mill *precision draws* tubing to your specifications. Also UNIFORM is uniquely equipped to fabricate dimensionally accurate tubular parts.

ALLOYS—Beryllium-Copper, OFHC, 85/15 Red Brass, 90/10 Commercial Bronze, 70/30 Brass, 67/33 Yellow Brass, Grade "A" Phosphor Bronze, 18% Nickel Silver, 30% Cupro Nickel, and Phosphor Copper.



SIZES—O.D.'s from 0.005″ to 0.625″. Wall thicknesses from 0.001″ to 0.035″.

TOLERANCES — ±0.002″ to ±0.00025″ on smaller sizes if required. Tube lengths are cut as close as ±0.003″ with ends concentric and free of burrs.

DELIVERY—Normally within two weeks, but if needed "yesterday," orders receive immediate, fast action.

Fine seamless tubing and fabricated parts are also available in the precious metals, aluminum, nickel, stainless steel, steel and glass-sealing alloys. Write for particulars today.

UNIFORM TUBES, INC. COLLEGEVILLE 2, PA.
HUxley 9-7278 TWX-CGVL 1044

Circle 48 on Reader-Service Card

The following list compiled from recent issues of the Patent Gazette gives you increased coverage of new patents whose details may be useful to product and machine designers. Copies may be obtained from the U. S. Commissioner of Patents, Washington, D. C. The price is 25c each.

ROTARY, HYDRAULIC PUMP AND MOTOR TRANSMISSION
U S Patent 2,993,339; Jack T. Timms, Newcastle-upon-Tyne, England, assignor to George Angus & Co., Ltd., Newcastle-upon-Tyne, England.

AIR METER
U S Patent 2,993,374; Frank W. Dwyer, Oak Park, Ill., and John Locke, Michigan City, Ind., assignors to F. W. Dwyer Mfg. Co.

MOTOR-PUMP
U S Patent 2,993,449; Raymond F. Harland, Southington Conn., assignor to Hydratomic Engineering Corp.

FLUID PRESSURE-ACTUATED CONTROL MECHANISM
U S Patent 2,993,474; Joseph M. Ladd, Hamtramck, Mich., assignor to Holley Carburetor Co., Van Dyke, Mich.

REGENERATIVE HYDRAULIC CONTROL VALVE
U S Patent 2,993,477; Hugo A. Panissidi, Peekskill, N. Y., assignor to International Business Machines Corp., New York, N. Y.

ENGINE-COOLING FAN MECHANISM
U S Patent 2,993,483; Oscar G. Erickson, Highland Park, Mich., assignor to Charles L. Erickson, Birmingham, Mich.

GOVERNOR MECHANISM
U S Patent 2,993,499; Thomas R. Stockton, Northville, and Norman T. General, Detroit, Mich., assignors to Ford Motor Co., Dearborn, Mich.

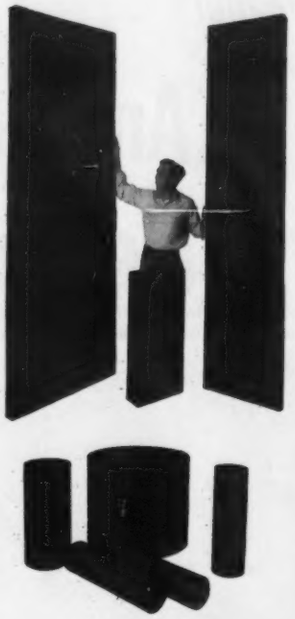
PRESSURE REGULATOR
U S Patent 2,993,507; James U. Daly, Latrobe, Pa., assignor to Robertshaw-Fulton Controls Co., Richmond, Va.

TEMPERATURE-STABILIZED PRESSURE-RESPONSIVE SYSTEM
U S Patent 2,993,514; Charles R. Suska, Roxbury, Conn.

HYDRAULIC TRAILER BRAKE AND COUPLING APPARATUS
U S Patent 2,993,568; Howarth Padgett Henry, 140 W. 42nd St., New York, N. Y.

AUTOMATIC LOCK FOR SMALL SHAFTS
U S Patent 2,993,569; Howard W. Cole, Jr., 12 Vale Dr., Mountain Lake, N. J.

FRICTION UNIT ASSEMBLY FOR BRAKE OR CLUTCH STRUCTURES
U S Patent 2,993,577; David N. Goldberg, 1510 Main St., Wheeling, W. Va.



THESE MASSIVE NEW NYLON SHAPES CAN SAVE YOU MONEY!

Nylon has been proven in service as an outstanding bearing material because of built-in lubrication, ability to withstand abrasive and corrosive environments, and mechanical strength. And MC* nylon, newest of the nylon family, is more adaptable than any and most economical of all. Tubular bars, for example, cost less than other nylon formulations . . . even less than continuous cast bronze. Plate and rod sell at prices under competitive nylons.

POLYPENCO MC nylon has premium properties similar to nylon 101 with outstanding wear life, strength and resistance to deformation under load. Typical applications: rollers, bearings, bushings, gears, cams, forming devices, wear plates, tooling and general structural wear parts.

AVAILABILITIES

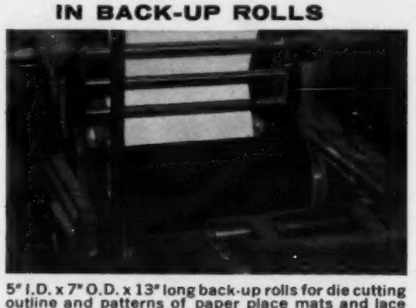
TUBULAR BAR: 2″-15″ O.D.
SOLID ROD: 3″-24″ O.D.
LARGE PLATE: ¼″-6″ Thick

SPECIAL SIZES AND SHAPES ON REQUEST

IN BUSHINGS

Non-scarring work holder bushings for disc grinding roller bearings.

IN BACK-UP ROLLS



5″ I.D. x 7″ O.D. x 13″ long back-up rolls for die cutting outline and patterns of paper place mats and lace doilies save $2000 per machine in cost of rolls alone replacing Kraft paper rolls.

IN DRIVE ROLLERS

Support rollers for end grinding roller bearings.

*Trademark of The Polymer Corporation

THE POLYMER CORPORATION OF PENNSYLVANIA
Reading, Pennsylvania
Engineered Industrial Plastics
EXPORT: Polypenco, Inc., Reading, Pa.

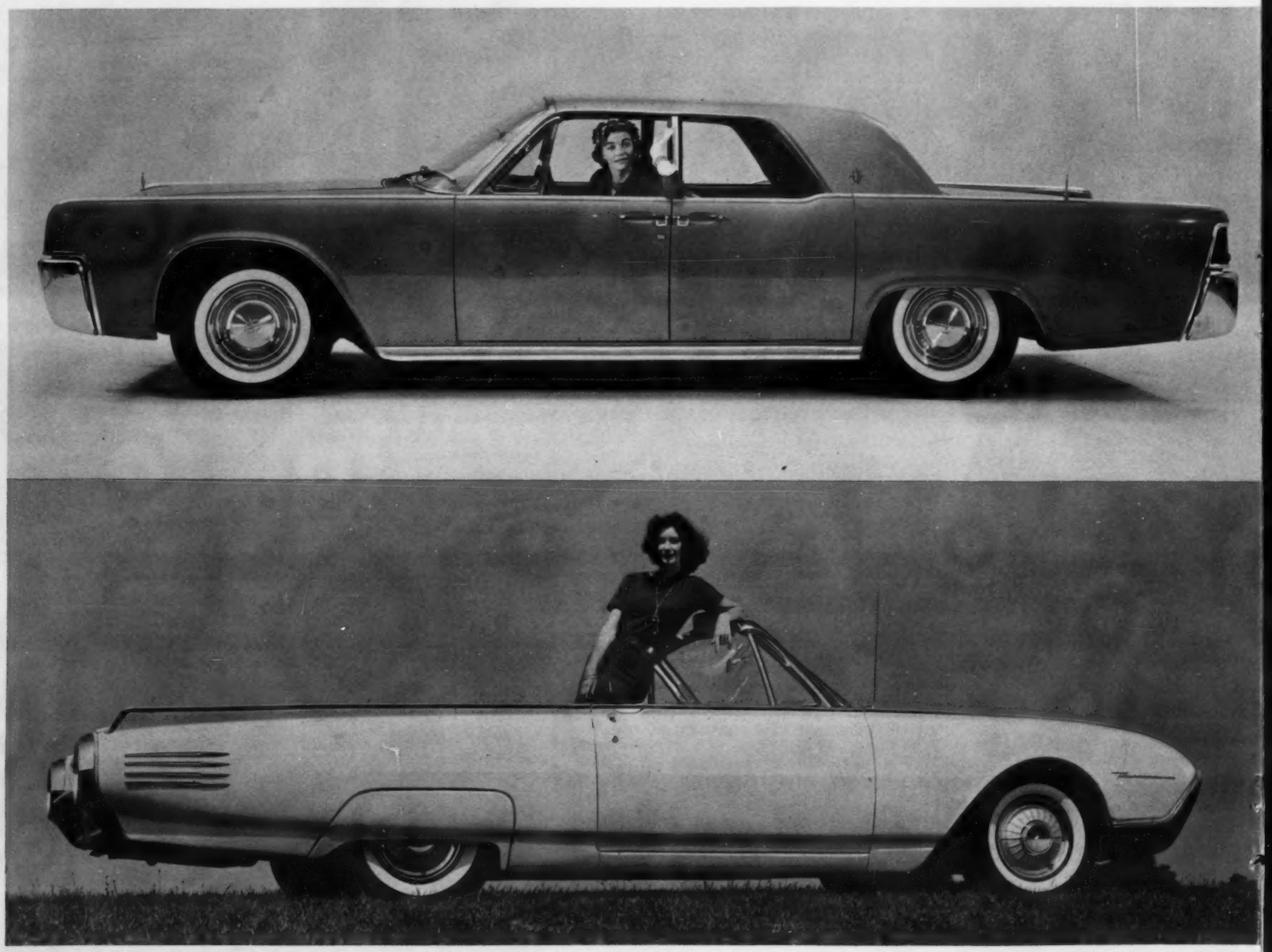
STOCK SHAPES • MOLDING RESINS • SINTERED PARTS • WHIRLCLAD® COATINGS

Circle 49 on Reader-Service Card for more information

Take a lead from the leaders . . .

Amchem GRANODINE* Phosphate Protection

Ford Motor Company's luxurious Lincoln Continental and fabulous Thunderbird have established new heights of fine car performance while creating "classic" standards in motor car design.



Coatings Provide Pre-Paint in Depth for Lincoln Continentals and "T-Birds"

Phosphatizing process key to producing rust-proof bodies, long lasting, quality paint finishes

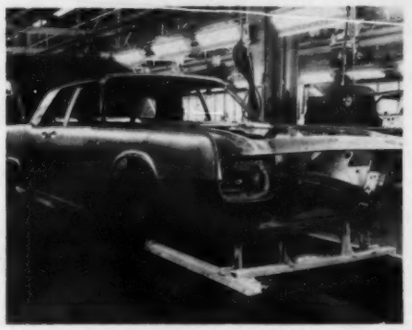
At Ford Motor Company's Lincoln Continental and Thunderbird production plant quality manufacture is the by-word as experienced craftsmen turn out the last word in automotive style and performance.

High among the many quality operations incorporated into these fine cars is the special attention lavished on the pre-paint chemical treatment of bodies and other steel and galvanized automotive parts.

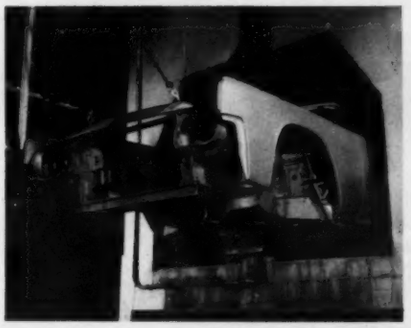
Utilizing the production-proven advantages of Granodine zinc phosphate coatings, this world-renowned automobile producer is providing potential buyers with the ultimate in quality body work, the result of Granodine's greatly improved corrosion resistance and bonding qualities combined with an already highly efficient baked enamel paint system.

Since 1933 Granodine has been demonstrating its dependability in industrial pre-paint operations. Amchem's experience and technical know-how in metal protection techniques assure you that Granodine will meet present day high volume production schedules with minimum maintenance and operator attention. Call your local Amchem Representative for complete details.

*Amchem's registered trademark for its conversion coating chemical used to produce phosphate coatings on steel.



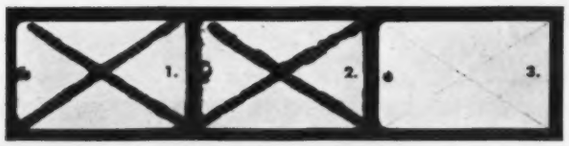
Body in white in metal finishing area prior to phosphating.



Granodine-treated body at exit end of phosphate washer.

Phosphatized body is seen in final paint line.

GRANODINE—The obvious difference in pre-paint treatments



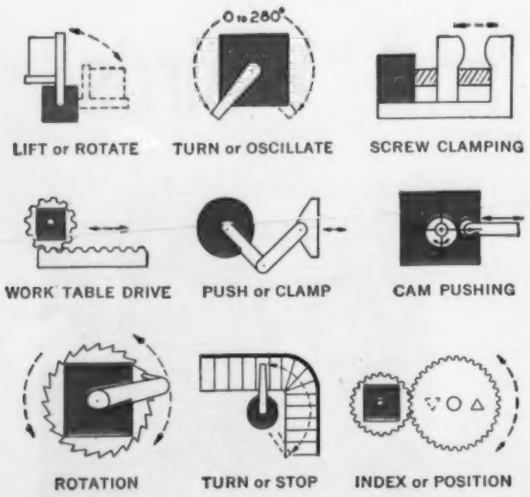
1. Solvent-cleaned—panels failed after 100 hours of accelerated testing.
2. Alkali-cleaned—panels failed after 100 hours of accelerated testing.
3. Granodine-treated—panels excellent after 336 hours of accelerated testing.

AMCHEM **GRANODINE**

Amchem is a registered trademark of **AMCHEM PRODUCTS, INC.** (Formerly American Chemical Paint Co.)
AMBLER, PA. • Detroit, Mich. • St. Joseph, Mo. • Niles, Calif. • Windsor, Ont.

Circle 142 on Reader-Service Card for more information

ROTAC Does All This...



with POWER to spare!

Rotac Reciprocating Rotary Torque Actuators are used wherever you need instant torque in a compact package—with power to spare! Simple valving controls speed and movement in any arc to 280°. Use air, oil or fire-resistant fluid for power. Torque ratings of standard models up to 200,000 in. lbs. (Special designs exceed 1,000,000 in. lbs.) Choose from over 26 cataloged models (with over 300 "standard modifications"), plus the new 12-ounce, 2" x 2" x 2" Midget Rotac.

Free design data book gives complete specifications and application details. Call your Rotac Representative, or write direct.

EX-CELL-O FOR PRECISION

EX-CELL-O CORPORATION

61-52RO

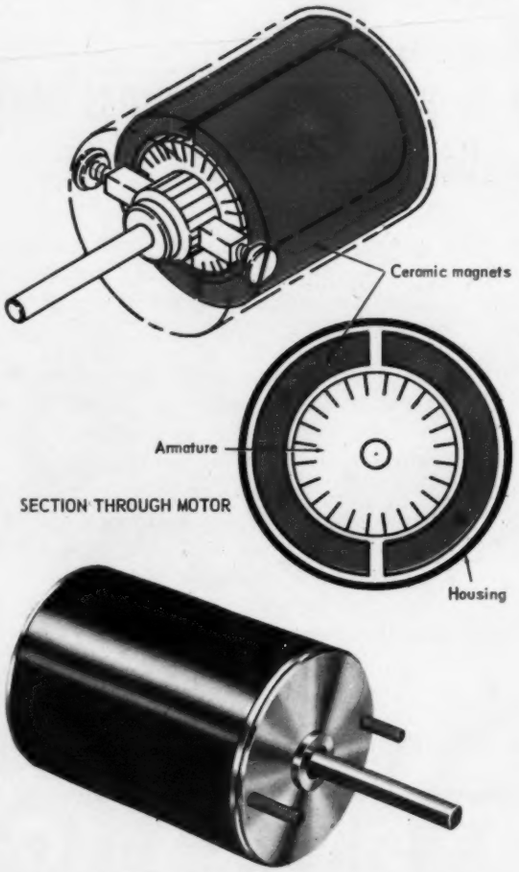
Greenville Plant, 945 E. Sater St. • Greenville, Ohio

PRECISION MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • JIG AND FIXTURE COMPONENTS • TORQUE ACTUATORS • CONTOUR PROJECTORS • GAGES AND GAGING EQUIPMENT • GRANITE SURFACE PLATES • COMPUTER PRODUCTS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS ATOMIC ENERGY EQUIPMENT • DAIRY AND OTHER PACKAGING EQUIPMENT

Circle 50 on Reader-Service Card for more information

Ceramic Magnets Replace Field Structure,

E. J. Stefanides, Central States Editor



CERAMIC-PERMANENT-MAGNET MOTOR is available in sizes producing from 1/100 to 1/8 hp at 2500 rpm with voltage requirements from 6 to 32v d-c. It also can be supplied for application with speed requirements from 1500 to 10,000 rpm or for use as generator. Motor is designed for face mounting on either end. Ceramic magnets are bonded to inside of steel housing which provides magnetic return path. Poles are located on ID of magnets. Brushes are removable for service.

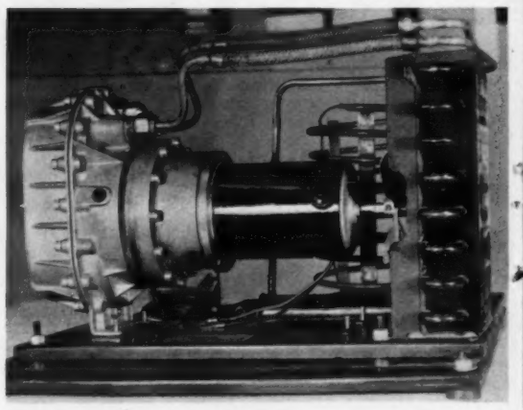
Ceramic magnets are used for the field structure of a new line of small, low-voltage d-c motors (or generators) suitable for automotive and marine accessory application. The use of ceramic magnets in a motor designed to utilize the peculiar properties of the material has resulted in a smaller, lighter, more efficient motor than was previously available.

In the new motor, the only electrical circuit is in the armature. All field coils and windings are replaced by two permanent ceramic magnets attached to the steel motor housing. As a result, no power is supplied to the field poles and the permanent-ceramic-magnet motor has inherently less power loss and therefore greater efficiency.

A typical motor draws only 10.5 amps of current to produce the power of a conventional motor which draws 12.5 amps. Because of this increased efficiency, there is less heat rise and a totally enclosed design can be used. This dispenses with the need for internal fans and ventilation. The magnetic material itself can be used in ambient temperatures as high as 650F without loss of magnetic properties.

Formerly, good quality permanent-magnet motors were too expensive to be used in anything other than military applications. Recent developments in magnetic ceramic materials and in new techniques for their use have made this type of motor economically feasible for more general application.

One of the problems in design of permanent-mag-



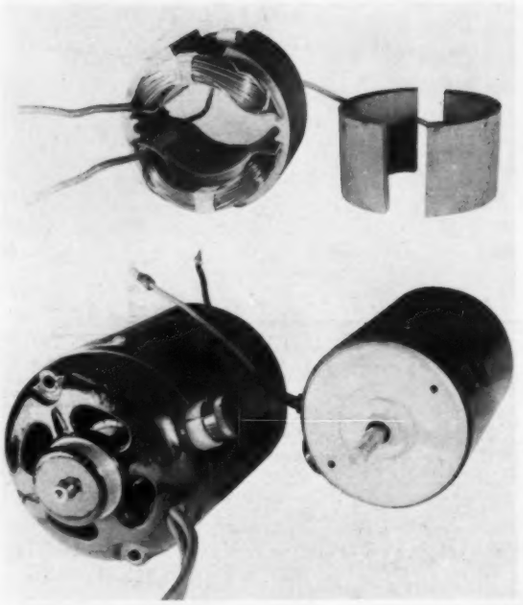
COMPRESSOR DRIVE for small, self-contained air-conditioning unit for yacht or trailer installation. Weight, size and motor efficiency are at premium in this type of installation.

Raise Output of D-C Motors

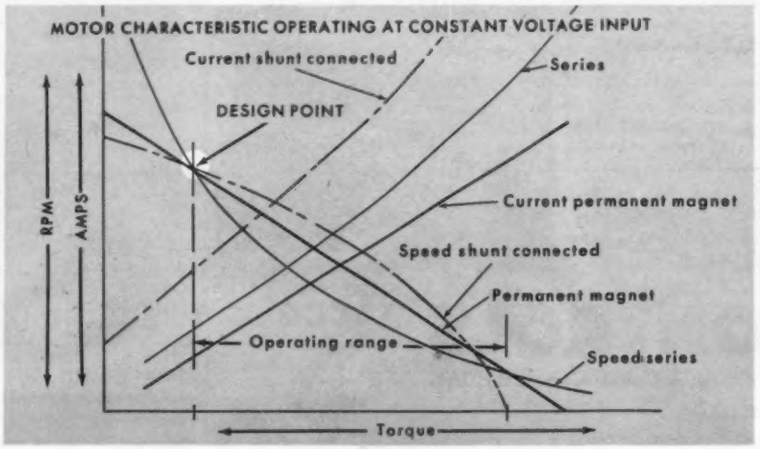
net motors was providing a relatively inexpensive magnet material which would not be demagnetized by reaction of the armature current. The ceramic material, because of its high coercive force, overcomes any tendency toward demagnetization. Also, the ceramic material can be magnetized with a very short polar axis, thus providing a motor having minimum outside diameter. Minimum dimensions, light weight of the ceramic material and elimination of the field laminations and coils are responsible for the lighter weight of the motors.

Design of the motor involved more than the mere substitution of the magnets for the field structure. Although basic engineering and electrical design laws applied, a great deal of empirical work was required before the full significance of some of the ceramic's properties could be realized. Useful flux density of the field was lower than usual. This required the armature to be especially designed to attain good electrical and magnetic balance between armature and field. Performance characteristics are a combination of a series and shunt motor. Because of its torque and current demand characteristics, it can perhaps best be compared to an accumulative-compound motor.

The motors are designed and manufactured by the Redmond Co., Inc., Owosso, Mich., a subsidiary of Controls Co. of America.



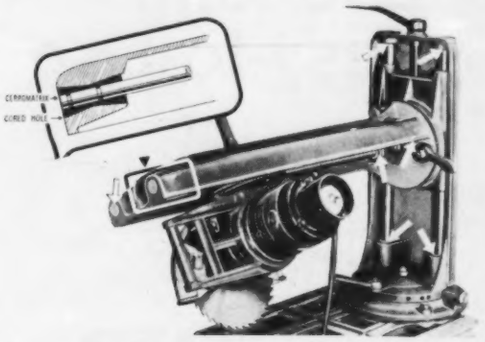
FIELD STRUCTURE of ceramic-permanent-magnet motor is smaller, lighter and simpler in design than that of conventional motors of same rating. Reliability of motor also is improved as number of circuits which can fail is reduced and lower power consumption and heat rise allows use of totally enclosed design. Motors shown are both 12v d-c, rated at 1/8 hp at 2500 rpm. Permanent-magnet motor weighs 4 lb, draws 10.5 amps; conventional motor weighs 6 lb 10 oz, draws 12.5 amps.



PERMANENT-MAGNET MOTOR CHARACTERISTICS in comparison with series and shunt motors. Note lower current requirements of permanent-magnet motor. Design point is at 2500 rpm, intersection of torque curves. Improvement in efficiency results in power savings as high as 20 percent in some models.

CERROTECHNICS saves **TIME & MONEY**

Anchoring Non-Moving Parts in Machinery



CERROTECHNICS — The technology of using CERRO* ALLOYS to expedite industrial operations

In this case, a few pounds of CERROMATRIX saves about 37 hours of machining time. These radial saw slide rods are aligned in oversize holes with holding fixtures. CERROMATRIX is then melted and poured around the rod bases. Send for full information.
*T.M. Cerro Corp.

CERRO SALES CORPORATION
SUBSIDIARY OF CERRO CORPORATION
Room 1500, 300 Park Avenue, New York 22, N.Y.

Circle 51 on Reader-Service Card for more information

PLATECOIL®

FOR ALL KINDS OF TANK AND PROCESS HEATING AND COOLING

- Built to fit application requirements
- High heat transfer capacity
- Compact units save space
- Easy to install
- Easy to remove for cleaning
- Available in variety of weldable metals
- Operating Pressures up to 250 psig.

"Platecoil" can be furnished to comply with ASME code

Send for Bulletin P51

PLATECOIL® DIVISION

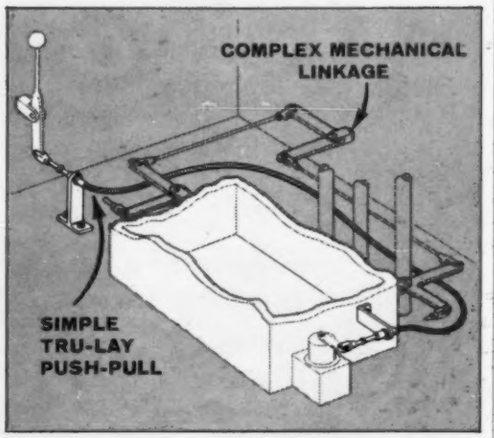
TRANTER MANUFACTURING, Inc., LANSING 9, MICHIGAN

Circle 52 on Reader-Service Card for more information

TRU-LAY *PUSH*-PULL CONTROLS PROVIDE

Dependable Economical Easy-to-Use REMOTE CONTROL

• If your products involve remote control—electrical, hydraulic, pneumatic or direct—TRU-LAY PUSH-PULL FLEXIBLE CONTROLS can help solve your design problems. They provide positive remote control over long or short distances—up to 150 feet from the control point. Because they operate while flexing, they can snake around obstructions. They will not buckle. They're factory-lubricated for life, unaffected by temperature extremes. They are ruggedly constructed, easily installed and operated, sealed against dirt and moisture, and will handle jobs with as much as 1,000 lbs. input. PUSH-PULL CONTROLS are simple, have but one moving part, are noiseless, and give a lifetime of accuracy. Mechanical linkages, on the other hand, are complex. Unlike PUSH-PULL CONTROLS, they are made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.



CABLE SIZES AVAILABLE

Control Dimension	Minimum Recommended Radius in Inches	Maximum Input Load in Pounds (Dependent on Travel)
3/32"	2	30
1/8"	3	65–125
3/16"	5	115–175
1/4"	6	300–600
5/16"	8	700–1,000

Operating Heads to Fit Your Design
for loads up to 125 lbs.

Heavy Duty • For rugged duty, but where operation must be smooth and accurate. Meets all requirements for dependability and life.

Light Duty • Smooth, accurate, dependable performance at low cost. Your choice of several types of knobs.

Selective Friction • Amount of friction can be changed to meet individual requirements. Friction constant at any setting.

Position Lock • A slight turn of the T-type handle locks the control in any position. Two sizes for light and heavy-duty applications.

Micro Control • Push or pull the knob for instantaneous response, then rotate knob for vernier adjustment.

***PUSH*-PULL DATA FILE SHOWS HOW TO SIMPLIFY, IMPROVE DESIGN**

• Write for your PUSH-PULL Data File. It contains a complete set of engineering bulletins which describe in detail the operation of PUSH-PULL CONTROLS, their applications, features and advantages.

PUSH-PULL CONTROLS

Automotive and Aircraft Division • American Chain & Cable Company, Inc.

601-B Stephenson Bldg., Detroit 2

6800-B East Acco Street, Los Angeles 22 • 929-B Connecticut Ave., Bridgeport 2, Conn.

ACCO

Circle 53 on Reader-Service Card for more information

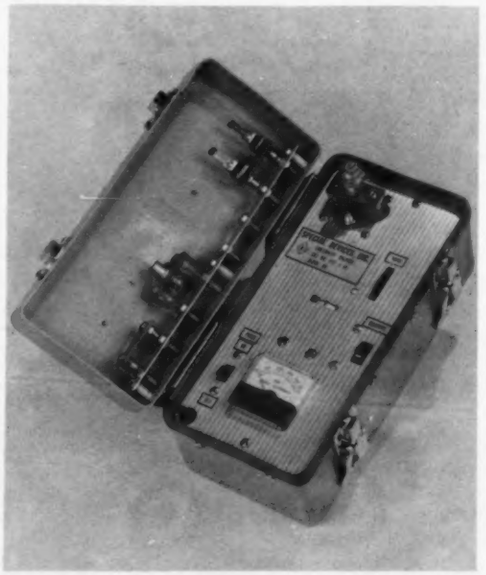
Parallel Resonance

Edward W. Schrader, Western Editor

An exploding bridgewire squib, designed with an inherent capacitance, lends itself to continuity checking by parallel resonance circuits. The inherent capacitance in the squib is coupled with the coil inductance in the checker to produce a natural resonance of a known frequency. The arrangement is a pair of simple tank circuits.

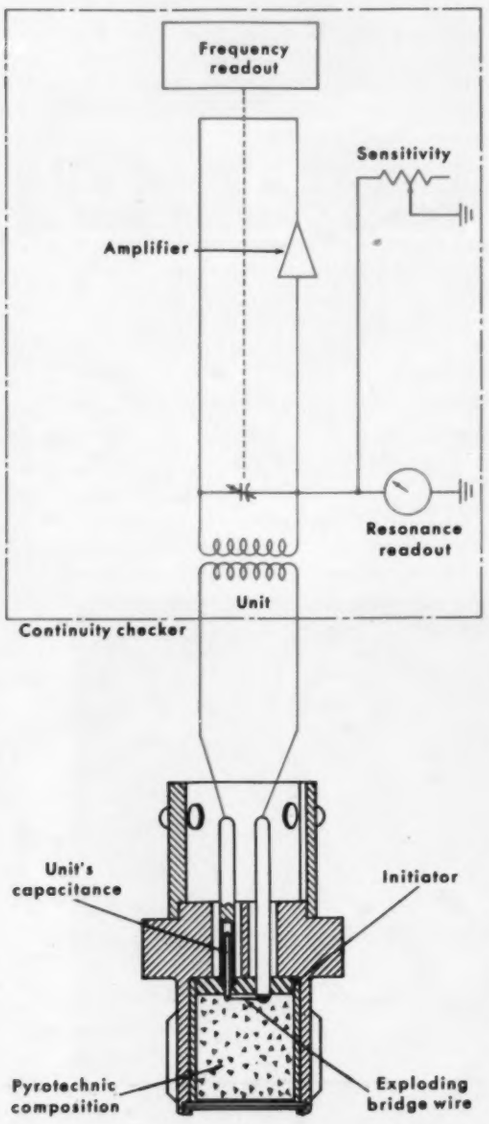
The continuity checker drives a high frequency signal into the EBW squib to be checked. The capacitance of the squib is measurable only at the external pins and through the continuity of the bridgewire to be checked. Should the bridgewire circuit be open, the design capacitance in the EBW is not measured by the continuity checker, and the frequency measured is dependent only on the stray capacitance of the system; therefore, frequency discrimination determines the existence of bridgewire continuity. Only millivolts are used to perform this check, thus making it extremely safe for use with this type of EBW squibs.

The EBW initiator and the continuity checker are design developments of Special Devices, Inc., Newhall, Calif.



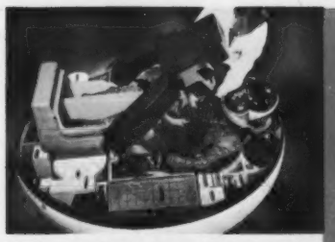
CONTINUITY CHECKER with EBW initiator in place for testing is tuned for minimum microamps in resonant circuit. If frequency readout is within design limits, EBW initiator is free of either opens or shorts.

Circuit Checks EBW Squib

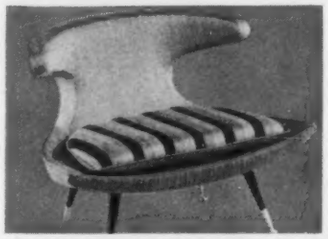


PARALLEL RESONANT TANK CIRCUITS supplied by continuity checker measure frequency of minimum resonant current in exploding bridgewire initiator. Variable capacitor tunes frequency for current dip at resonance. Exploding bridgewire has designed inherent capacitance between extension pin connected to bridgewire and internal cavity in receptacle pin. This capacitance gives a-c protection to any low-frequency signals and protection to low-voltage, high-frequency signals, while having no continuity to d-c signals.

☐ USED FOR INSULATION, urethane foam has a K factor of .11 to .16.



☐ AMERICA'S SPACE PROGRAM uses urethane cushioning, insulation.



☐ MOLDED CHAIR, another "first" for urethane foam in furniture industry.

☐ SPRAYED-IN-PLACE urethane foam insulation is quick, easy, efficient.

☐ URETHANE INTERLINING gives warmth-without-weight in clothing.

☐ FOAMED-IN-PLACE URETHANE insulates refrigerated trucks, reefers.

☐ REUSEABLE FILTERS of urethane for air cleaners, air conditioners.

☐ ACOUSTICAL TILE of decorative urethane foam for homes and offices.

☐ CONTOUR-CUT urethane foam cushions delicate items in transit.

☐ URETHANE CURTAIN WALLS go up fast, provide excellent insulation.

want to zero in on knowledgeable information, experienced technical assistance and convenient source of supply for URETHANE FOAMS?

FOR FAST ACTION . . . check mark your main field of design interest, tear out ad and mail to:

MOBAY CHEMICAL COMPANY
Code DS-18 Pittsburgh 5, Pa.

MOBAY
First in Urethane Chemistry

NAME _____ TITLE _____

COMPANY _____ ADDRESS _____

Circle 54 on Reader-Service Card for more information

DESIGN NEW PRODUCTS NEWS

Circle number on Reader Service card for more information

Insulated Tubing 301

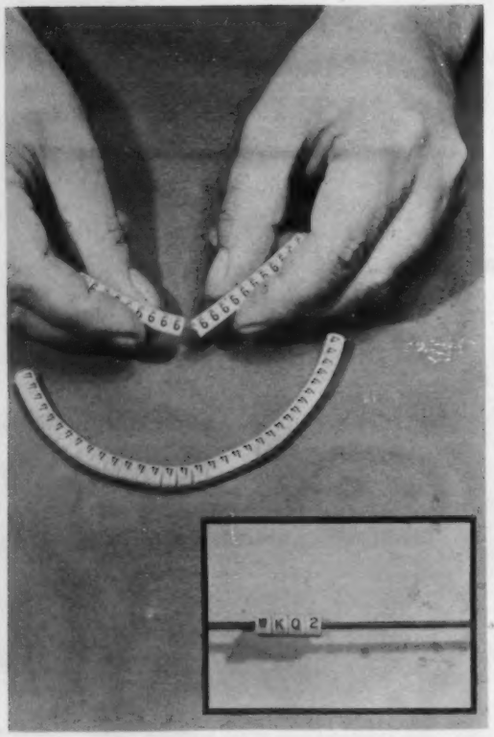
Imprinted in Standard Codes

"Idensulation" speeds up assembly time because coded tubing is card-mounted with adhesive-backed tapes in numerical, alphabetical or subassembly order. This matches the user's connection list or wire-routing operation sheet. Cut sleeving is secured to perforated assembly work cards, which are separated easily for assignment to work-bench position. The coding system is available in many colors and in standard insulating materials, including "shrink-on" types. The material meets most industrial and military specifications. Stock items are offered in ASTM sizes 24 to 1-1/2, imprinted with standard codes. A sample of "Idensulation" may be obtained upon request.

Manger Electric Co., Inc., N. State St., Stamford, Conn.

Wire Identification Markers 302

Offered in Three Sizes in Six Wire Diameters



Insulated wires of AWG 18 or smaller now can be labeled for instantaneous identification with new small-sized markers. Type "Z" Beta markers are made in small diameters in response to the electronic industry's continuing developments in microminiaturization. They come in three sizes for the following wire diameters: 0.086 to 0.115, 0.066 to 0.085 and 0.050 to 0.065 inch. Markers are one-piece, completely closed, flexible units. They have an expandable, accordion-type pleat. This results in fast assembly and permanent marking. Markings include single numbers 0 to 9, letters A to Z, as well as symbols commonly used in the electronics field. Multiple combinations of 2, 3, 4 or 5 letters, numerals, symbols and special markings also are available. White with black is standard; color markers of blue, green, yellow, red or black with contrasting figures are also obtainable. Markers are offered in slotted rolls; individual markers are broken off by user as needed. The Type "Z" is made of durable polyvinylchloride; markings do not rub off. The system is recommended for instrument tubing and complies with military, civil and trade association specifications. For marking of cables or wire bundles with an OD in excess of 1/2 inch, Type "S" strap-in markers are recommended.

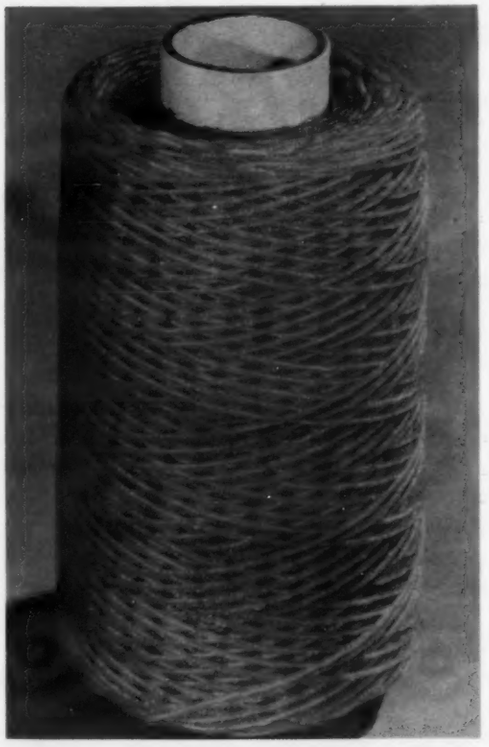
Electrovert, Inc., 124 E. 40th St., New York 16, N. Y.

Epoxy Glass Lacing Cord 303

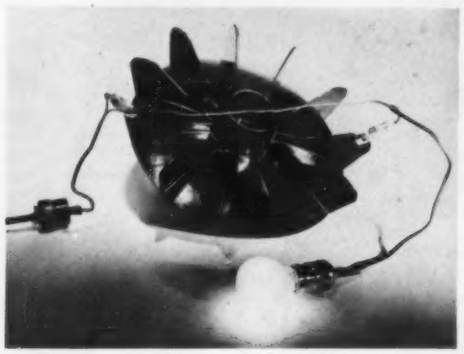
Acts as Self-Extinguishing Insulation

An epoxy-impregnated glass cord for electrical lashing and holding applications offers good bond and reinforcement qualities. The cord is fully impregnated with an uncured high-temperature epoxy resin, which prevents glass abrasion and weakening during handling and tying—it also thermosets to provide extra toughness and easier bonding. Applications include miscellaneous holding and tying on motors, generators, transformers and large coils and substitution for untreated glass cord used by railroad and other rotating-equipment repair shops. "Scotchply" XP-205 has a resin content of 26 percent, ±3 percent; tensile strength of 100 lb before curing, 210 lb after curing, and arc resistance of 120 sec. The material is self-extinguishing and offers a shelf life of three months at 70F, six to 12 months at 40F, and cures under tension in three hr at 300F. The insulation is furnished level wound on a 1-1/2-inch ID core.

Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.



Electrically Conductive Molding Compound 304



Parts produced with this conductive compound, designated as "Glastic Grade X-1011-F", exhibit good physical strength and corrosion resistance in addition to complete static draining. The material has wide application and can be molded into blowers for explosionproof equipment. It can be made into components for equipment used in such locations as operating rooms, paper conversion plants, textile mills, chemical plants, mines and printing plants. The compound is electrically conductive to the extent that it will show a zero Megger reading. Physical properties are: impact, IZOD notched—5 lb-ft per inch; flexural—16,000 psi; tensile—5000 psi. Black in color, the compound is available to custom molders and company molding divisions. Samples are obtainable.

Glastic Corp., 4321 Glenridge Rd., Cleveland 21, Ohio.

Dry-Film Lubricant 305

An improved bonded dry-film lubricant for cutting tools is now available. "Molykote PVE-K250" coating can be applied to any clean metal surface. It replaces "Molykote PVE" which could be applied only to low-alloy ferrous metals. In addition, the new compound is a single-package coating, in contrast to its predecessor which was a two-package system requiring mixing before application. The new lubricant lengthens the life of such tools as gear cutters, reamers and taps by preventing metal pickup or buildup on cutting tool flanks. It is applied easily by spraying and requires no surface preparation other than cleaning. After tools have been sprayed evenly with a thin coat and allowed to dry in air for 30 minutes, the coating is cured for 1 hr in an oven heated to 140F. Parts are ready to use after cooling.

Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn.

NAME YOUR STAINLESS SHAPE!

The design and manufacture of quality stainless steel castings is a specialized job . . . *and Dodge specializes in it!*

There is practically no limit to the variety of shapes we can turn out to meet your simple or intricate specifications precisely . . . economically.

Perhaps one or more DS castings shown here will help spark an idea of how Dodge can be of assistance for *your* stainless steel casting needs. A blueprint or sketch with operational details will bring complete information, without obligation.

DODGE STEEL COMPANY

6501 State Road

Philadelphia 35, Pa.

• *Phone: DEvonshire 2-2200*

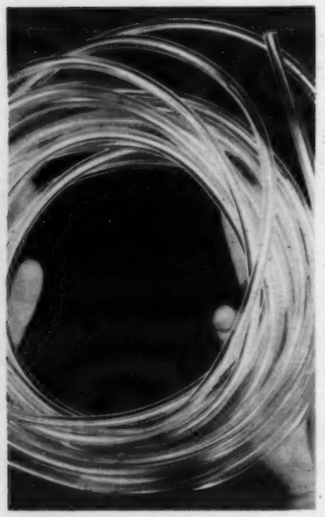
DS DODGE PRODUCTS

THE MOST IMPORTANT ALLOY IN A STAINLESS STEEL CASTING IS QUALITY

Circle 55 on Reader-Service Card for more information

Transparent PVC Tubing 306

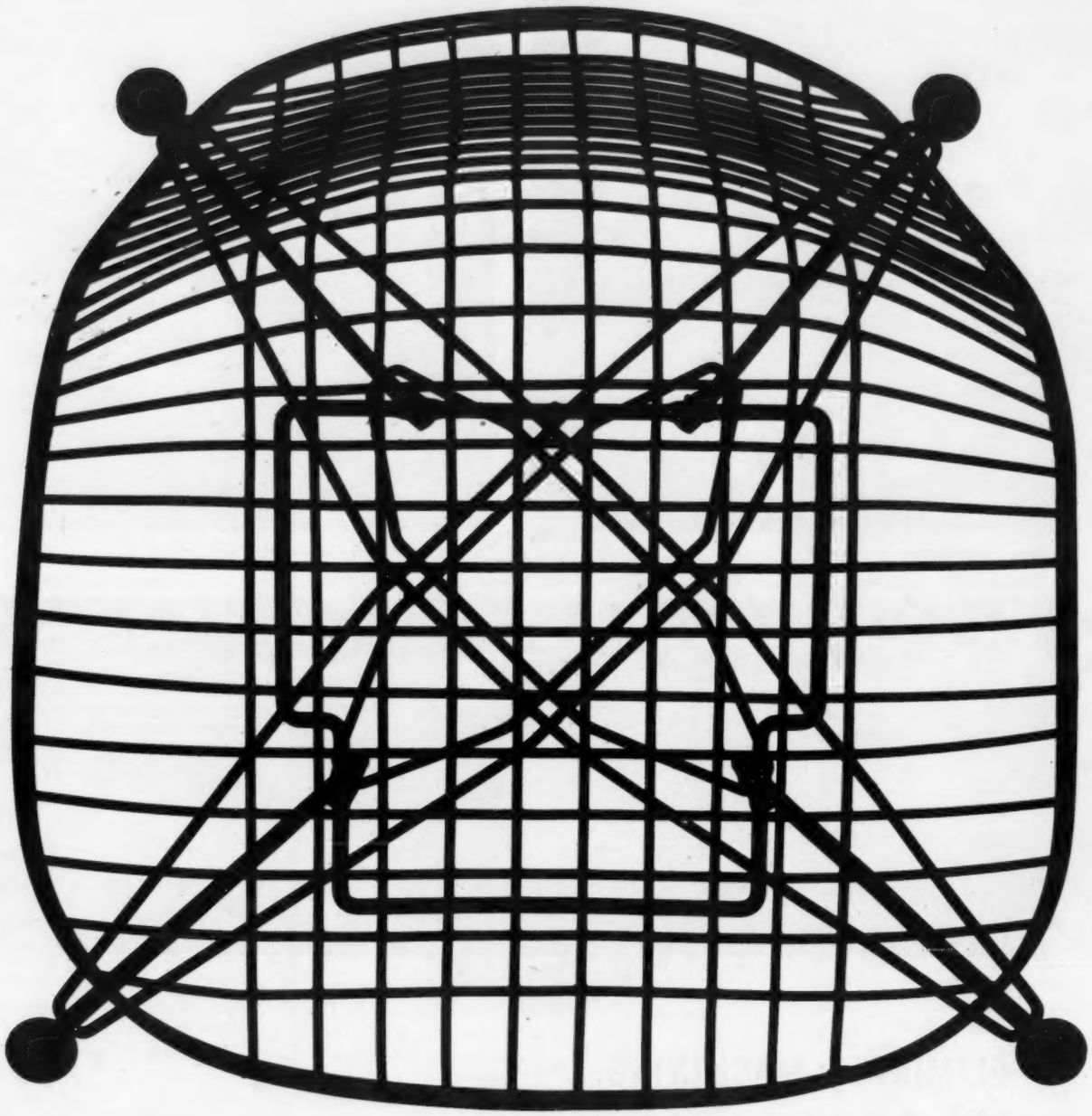
A low-cost, transparent, polyvinylchloride (PVC) tubing combats corrosion in the transmission of gases, acids, alkalies, petroleum products, sea water and numerous other active chemicals or materials. "Clearflo" is also available in a Food Grade Formulation ("Cleartlo F.G.") which can handle delicately flavored substances with safety. It is said to be ideal for use in bottling and filling machines. The material is nonporous with almost mirror-like interior and exterior surfaces which resist staining, bacterial growth and dirt accumulation. For use with high pressures and to resist crushing, the tubing is also available in two reinforced versions. One is reinforced with a steel-wire spring and the other version features a nylon braiding, having burst pressures up to 1000 psi. The reinforcing media are not exposed to either the OD or ID of the tubing. Free samples are available.



Newage Industries, Inc., 222 York Rd., Jenkintown 46, Pa.

Get a new perspective on your product. Do it with steel wire!

Ten years ago, Charles Eames designed the steel wire chair shown here for Herman Miller Inc. In a serious exploration of the use of steel wire, Eames took this good and familiar material and used it in a unique new way for the home. By exploiting the facts that wire performs best in tension and lends itself to multiple welded connections, Eames developed this design in his continuing search for "minimum structure" for a chair. Today, after a decade of continuous production, the chair remains a design example for its exceptionally high weight-strength ratio as well as its comfort. ■ Wire is cold drawn through dies, and this cold reduction gives wire its great strength and smooth surface. It is available in a vast range of sizes, in hundreds of steel chemistries, just about any surface finish, and in strengths that range up to over 600,000 psi. Wire can be fabricated in high speed automatic wire forming machines to form complex products to high performance standards at very low cost. At American Steel and Wire, we draw round, square or hexagon wire, and can ship it in 1,000 pound coils that do not contain a single weld if you desire. ■ Our wire is manufactured to your specific end use product requirements, and is warranted to perform satisfactorily in your production line. ■ When you consider the usefulness of steel wire, is it any wonder that so many designers are looking at their products from a new angle in the hope that they can make a stunning design breakthrough with steel wire? After all, Charles Eames did it. American Steel and Wire, Rockefeller Building, Cleveland 13, Ohio.



USS
TRADEMARK

American Steel and Wire
Division of
United States Steel

Circle 56 on Reader-Service Card for more information

Silicone Weatherproofing 307

Weather covers treated with silicone rubber are said to remain flexible at all temperature extremes while providing long-term protection to equipment. The material, SE-100, is applied as a white, putty-like substance and is cured to the fabric with the application of heat. An important feature of the coating is its microwave transparency, which allows transmission up to 25,000 mc. Fabric used for this purpose is 6.35-oz-per-sq-yd, polyester fiber balanced. coated with a thickness of 0.020 inch, ±0.002 SE-100. The fabric has been considered for air-supported structures to provide protection to electronic tracking equipment.

General Electric Co., Silicone Products Dept., Waterford, N. Y.

Miniaturized Grommets 308

Thin cross-sections for lower weight factors and small ID's are features of grommets suited to miniaturization programs in electronic and missile industries. Sizes offered are as small as 0.059 inch ID and 0.072 inch thick. Grommets are manufactured in rubber or in synthetic compounds, in high- and low-temperature silicones or in other special elastomers.

Minor Rubber Co., Inc., Ackerman St., Bloomfield, N. J.

Smudgeproof Plastic Lead 309

A new pencil lead enables draftsmen to quickly produce sharp, freehand lettering on polyester drafting film and water-resistant pencil cloth. Designed for use with any standard fine-line mechanical pencil, the lead is 0.036 inch in dia. It is claimed to assure the drawing of crisp lines that do not vary in width and are sharper and blacker than those made by a graphite pencil. The lead eliminates the time-consuming need for sharpening. Pencil leads are packaged in plastic dispenser, which is marketed 12 to a carton. Each dispenser contains 12 leads.

Keuffel & Esser Co., Third & Adams Sts., Hoboken, N. J.

Cup Packings 310

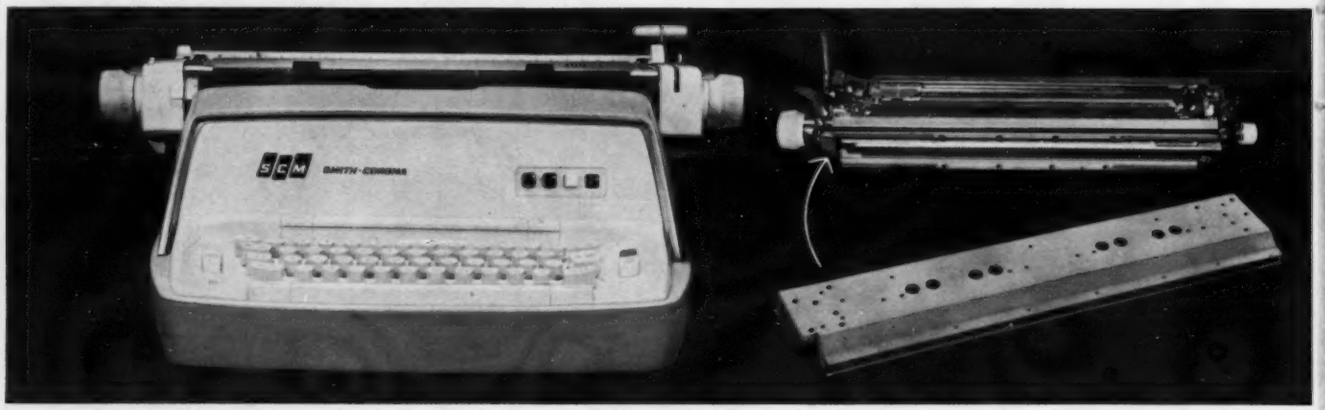
Leakage prevention and meter accuracy are features of cup packings made of "Rulon", a fluorocarbon compounded with reinforcing agents to make it chemically inert and resistant to wear, deformation under load and wide temperature variations. The material also offers a low coefficient of friction under nonlubricated conditions. "Rulon" will withstand gasoline additives and high mechanical stress. It is being used to manufacture other parts such as bearings, bushings, cam followers, wear strips and insulators, shaft seals, thrust washers and sleeve bearings.

Dixon Corp., Bristol, R. I.

Automotive transmission stator blade

Printer's furniture, The Challenge Machinery Company

Lightweight precision part for Smith-Corona "400"



ELIMINATE MACHINING, CUT PRODUCTION COSTS WITH MAGNESIUM PRECISION EXTRUSIONS

These close-tolerance parts were produced with no machining costs! They're Dow precision magnesium extrusions which require only end trimming or cutting to length before use . . . and where transverse holes are needed, drilling and tapping. Dow precision magnesium extrusions help manufacturers cut production costs, while providing tolerances as close as ± .001 inch on critical cross-sectional dimensions, dimensional stability and light weight. There is no machining on the typical parts above . . . component for the ultra-modern Smith-Corona "400" Office Electric Typewriter; The Challenge Machinery Company's printer's furniture; and automotive transmission stator blade. Precision magnesium extrusions can be produced with sharp V's, thin notches, and accurate serrations. Complex parts can be given a consistent precision fit. For information, write to THE DOW METAL PRODUCTS COMPANY. Midland, Michigan, Merchandising Dept. 1104AV8-29.

DOW

THE DOW METAL PRODUCTS COMPANY
Division of The Dow Chemical Company

DOW

NEW DOW MAGNESIUM ALLOY ZE10A

high welded joint strength and no stress relief!

New Dow magnesium alloy ZE10A needs no post-welding stress relief. This strong sheet alloy is ideal for fabricating containers, vehicle bodies and other structures . . . and for field repair operations where stress relief can be a real problem.

ZE10A provides very high welded joint strength, important in butt welding of plates. The result—strong, stiff weldments of very light weight . . . with greater capacity, pound-for-pound, than structures made from any other metal!

To weld ZE10A sheet to extrusions, use Dow extrusion alloy ZK21A. No stress relief required. For further information and data, write THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Dept. 1152AV8-29.

ZE10A makes light, strong containers, like this Tote Bin, built by Tote Systems, Inc., Beatrice, Neb., a subsidiary of Hoover Ball and Bearing Company.

DOW

THE DOW METAL PRODUCTS COMPANY
Division of The Dow Chemical Company
Midland, Michigan

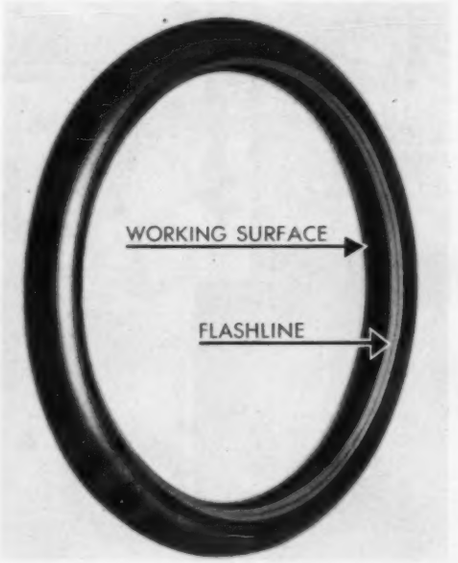
Circle 57 on Reader-Service Card

Urethane Foam Insulation 311

"Hewfoam" combines good insulating characteristics with high heat, solvent and moisture resistance and is well suited for use as a building insulation material. Providing a natural moisture barrier, the urethane foam is effective for checking humidity as well as temperatures. The rigid cellular foam contains more than 90 percent closed cells, making it useful also as a soundproofing insulation. Installation of the lightweight foam is rapid and is accomplished with fewer seams because of the large sections. "Hewfoam" may be obtained in either white or brown, fire-retardant or non-fire-retardant.

H. E. Werner, Inc., 2990 Industrial Blvd. Bethel Park, Pa.

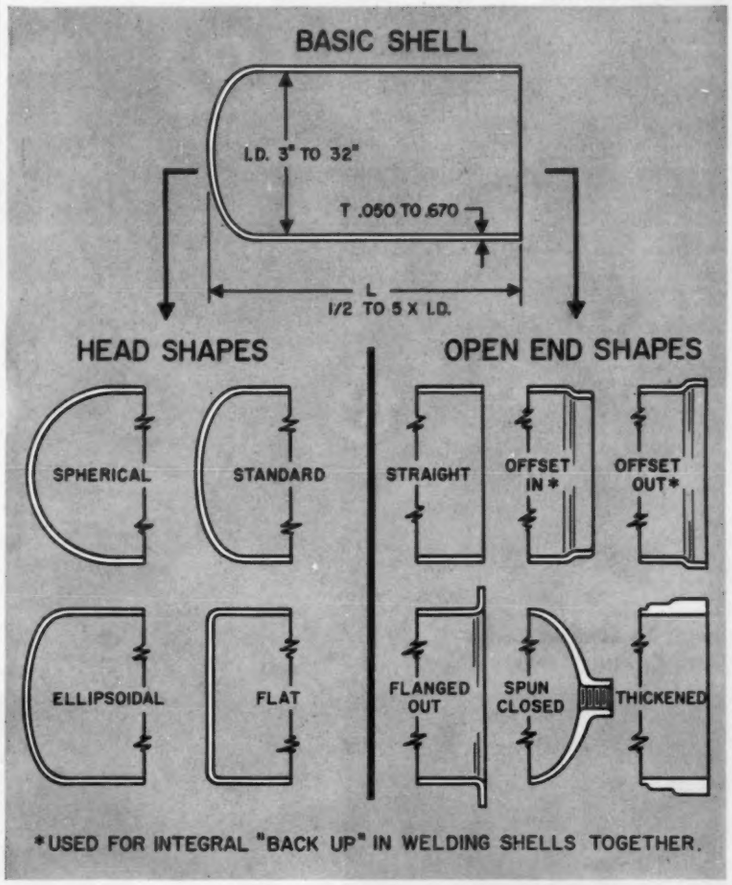
O-Ring Seals 312



A new development in O-ring seals is said to offer efficiency over a wide range of pressures, temperatures and tolerances. Flashline of the seals is not placed on centerline where ring is subject to wear. Two types of rings are available: moving type for reciprocating, oscillating, rotary and pneumatic seals and for small drive belts; and a nonmoving type used as vacuum seals, seat seals and flat gaskets. Limitations to efficiency would be such conditions as extremely high temperatures, excessive pressures, rotary speeds exceeding 1500 fpm contact speed and contact with fluids normally injurious to any rubber compound. Rings come in various sizes from 1/32 to 6-1/2 inches ID.

Shurclose Seal Co., 17411 E. Warren, Detroit, Mich.

Your ideas...our methods...give you reliable components at low cost



The drawings shown here give you a simple description of the way you can use basic Hackney shells to produce a variety of seamless, lightweight, strong, low-cost rocket motor cases, gas generator housings, control actuator pressure vessels and other missile components.

The basic unit is a cold drawn, deep shell which has uniform wall thickness from top to bottom in ranges from .050" to .670". I.D.'s vary from 3" to 32". The length of the shell may be from ½ to 5 times the diameter—or up to 110".

Head shapes—spherical, standard, ellipsoidal, flat or special. *Open end shapes* offer variety—straight cut, offset in, offset out, flanged out, flanged in, spun closed or thickened. *Capacities* begin at 1 quart—go as large as 100 gallons. *Working pressures* range from 100 to 6000 psi, depending upon diameter and wall thickness.

For full details of our facilities and our methods of making components, write to the address below.

Pressed Steel Tank Company
Manufacturer of Hackney Products Since 1902
1440 S. 66th Street, Milwaukee 14, Wisconsin
Branch offices in principal cities

Hackney
DOMINGTON IRON WORKS

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

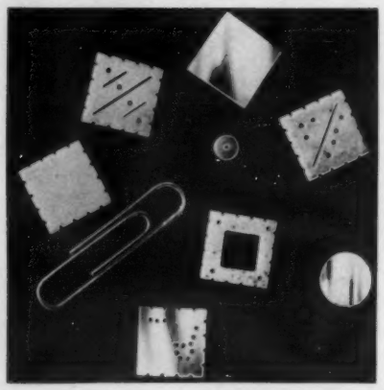
Circle 58 on Reader-Service Card for more information

Epoxy Coating 313

A single-package epoxy coating in solution form protects concrete, wood, magnesite, cork tile, linoleum and painted floors against traffic wear, deterioration and disintegration. Applied in the same manner as paint, "Sealaway" penetrates deeply and thoroughly, fills pores and voids, strengthens and reinforces flooring to form a hard surface. The material stops concrete "dusting" and prevents wood from splitting, shredding, splintering or rotting. It prevents staining from spillage of liquids and protects against disintegration from soaps and cleaning solutions. Dust and dirt cannot penetrate the dense film.

Hallemite Mfg. Co., 2446 W. 25th St., Cleveland 13, Ohio.

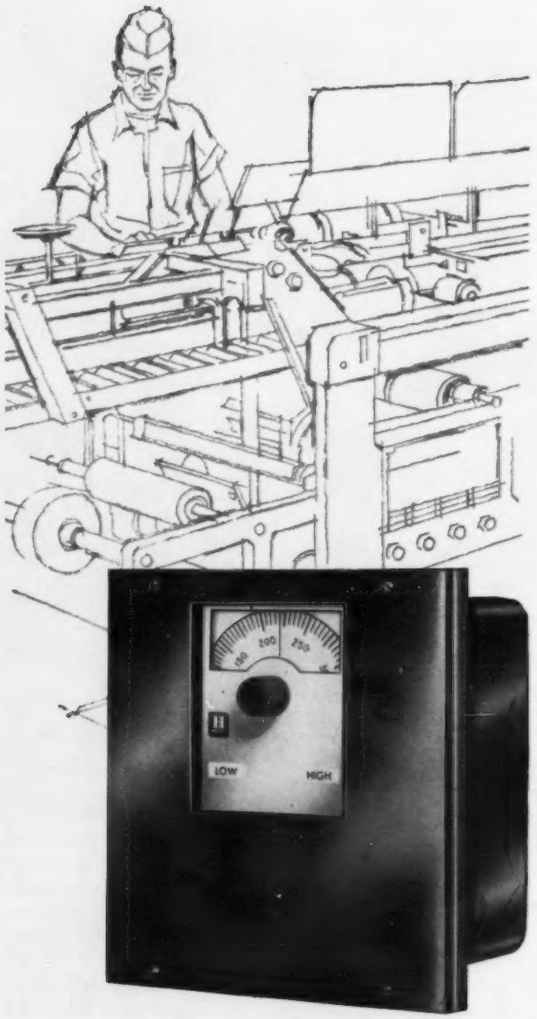
High-Precision Glass And Ceramic Parts 314



Materials such as glass, quartz, ferrites or germanium now can be fabricated to very rigid tolerances (dimensional tolerance of ±0.0005 inch on size of apertures and spacings). Extreme precision is observed in shaping, lapping, drilling, slitting and polishing of exotic and brittle materials. The process also provides for special optical finishes—gold, silver, aluminum and fluoride. Service is offered on glass, quartz or "Pyrex" parts for use in microminiature printed circuitry embodied in digital computers.

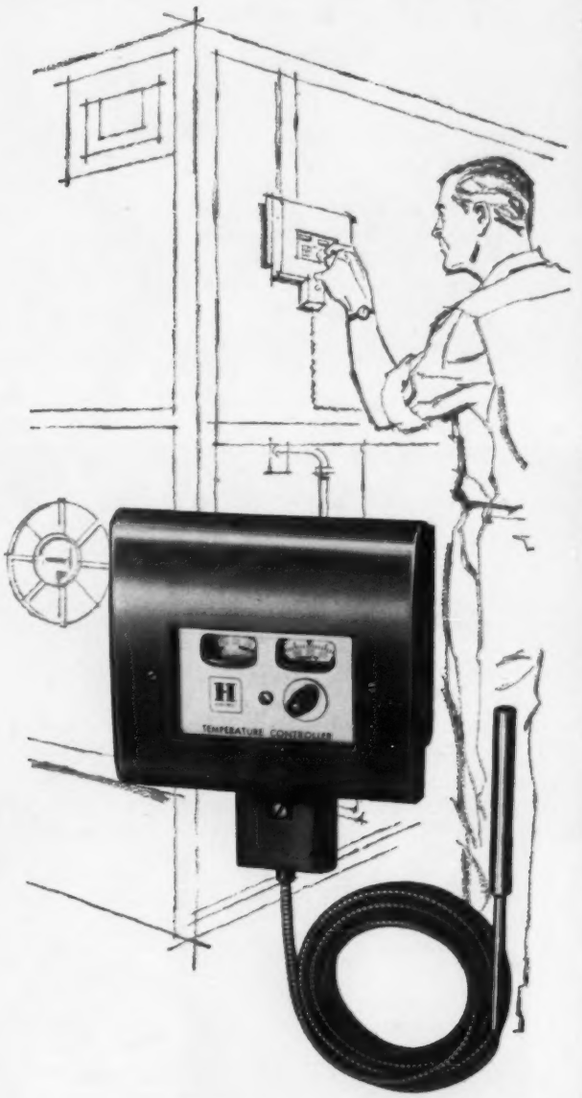
Zenith Optical Laboratory, Dobbs Ferry, N. Y.

Whether you choose by specification, price or both... **There's a Honeywell pressure control**



☐ **For precise control at low cost—R7086—R7087**

Temperature controllers for use wherever precision temperature control must be maintained. Ranges from −150° to +3000° F. are possible. R7086 uses thermocouple, R7087 uses resistance bulb. Both, surface or flush mounted. R7086 $150.00; R7087 *only $120.00.*



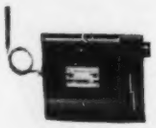
☐ **For accurate control with indication at low cost**

T654A indicates and controls temperatures on an evenly graduated scale accurate within 1% of scale range. This switch can control an *Actionator**, motor, relay, contactor or other device. Completely compensates for ambient temperature changes. Ranges from −150° F. to 1200° F.

temperature or to fit your exact needs!

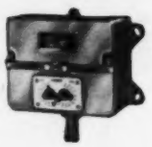
Whatever your application, you'll find the control that suits you best in Honeywell's complete selection

P444
For industrial applications that call for independent high-pressure and low-pressure settings and switching action. Adaptable for surface or flush mounting.



T444
For a wide variety of industrial applications requiring independent high-temperature and low-temperature settings and switching action. Adaptable for surface or flush mounting. Ranges from 0° F. to 660° F.

P428
For general industrial applications requiring the control or limiting of relatively high pressures. Models are made with explosion-proof case for hazardous locations. Ranges from 30 PSI to 5000 PSI.



T667
Designed for use as a remote-bulb temperature controller. SPDT switching provides temperature control in heating, cooling, or heating-cooling commercial and/or industrial applications. Ranges from —150° F. to 1200° F.

*Trademark

☐ For reliable control at minimum cost—VERSA-TRAN

This inexpensive controller is completely transistorized. Needs no tubes, no warm-ups . . . gives instant reaction. Works with sensors that can be thermisters, probes, resistance bulbs, pressure transducers or humidity elements. Available in various temperature, humidity and pressure ranges. *Standard models as low as $39.50.* Model shown above only $49.50.

Write Honeywell, Minneapolis 8, Minn.

HONEYWELL INTERNATIONAL Sales and service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

Honeywell

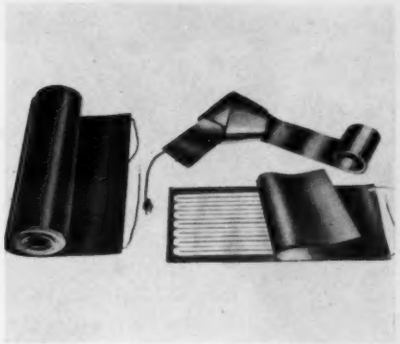
First in Control

SINCE 1885

Circle 59 on Reader-Service Card for more information

Etched Foil 315

A new type of construction, utilizing resistance alloy foil etched to shape, now can be used in the manufacture of flexible electric heater blankets. After etching, foil is laminated in neoprene, epoxy or silicone rubber to make a thin, waterproof and rugged blanket that meets military and UL specifications. The etched circuit eliminates wire windings, reducing overall costs significantly while offering improved thermal characteristics. Wide bands of foil provide more uniform heating, longer life and higher watt densities. Foils as small as 1 by 3 inches are etched and laminated in "Teflon" for very thin, high-performance heaters of



electronic components. "Heat sheets" are available in any desired size, shape, wattage and any voltage up to 480v, three-phase. Resistance as low as 0.1 ohm per sq ft is obtainable. Cutouts and holes may be provided as required without tooling costs. Leads can be brought out together or at any point on the periphery, and thermostats, two-prong plugs or quick-connect terminals can be provided. Heaters may be bonded in place, mechanically held or fastened with hooks, snaps or eyelets.

Thermal Circuits, Inc., 59 Park St., Beverly, Mass.

P-e-e-l-i-n-g down to a perfect fit

Just a twist of a pen knife when your shims are made of LAMINUM® and you have a perfect fit—right on the assembly line. No machining. No grinding. No counting. No stacking. No miking. No costly stand-by equipment.

LAMINUM is the registered trade name for laminated shim stock that looks and acts like solid metal. Plastic or metallic bonded, the laminations p-e-e-l off easily to give you a perfect fit—right to a thousandth—right on the job.

Custom-made to your own blueprint specifications—in any quantity—shims of LAMINUM are produced *exactly for your job.* In brass . . . mild steel . . . stainless . . . aluminum . . . laminations of .002″ or .003″. **And now also in Titanium with laminations of .003″!** You name it! You specify it! You have it!

Find out how LAMINUM can save you time and money on your assemblies. Just write for revised SHIM DESIGN FOLDER No. 4 for complete, up-to-the-minute engineering data.

LAMINUM®

THE LAMINATED SHIM COMPANY, INC.
West Coast Sales and Service – 600 Sixteenth St., Oakland, Calif.
Home Office and Plant - 1109 Union St., Glenbrook, Conn.

MATERIALS

Adhesive Coating 317

This adhesive provides good specific adhesion to metals, glass, some plastics and most porous materials for the conducting away of static charges. Resistance of the black material to oil, gasoline, water, heat and cold makes it well suited for use as a protective coating against rust and corrosion. Coatings can be applied by brushing. Each coat produces approximately 2-mil thickness of static-conducting surface. Corrosion-resistant coatings result from application of two or more brush coats with allowance of about 1 hr drying time between coats. One gallon will provide one-coat cover for approximately 200 sq ft. The adhesive produces a tough, elastic coating that becomes progressively tougher and more heat-resistant over a period of months. "Rez-N-Glue No. 159" is supplied with medium brush viscosity in 1-, 5- and 54-gal containers.

Schwartz Chemical Co., Inc., 50-01 Second St., Long Island City 1, N. Y.

Drawing Leads 318

Graphite (99.7 percent pure) and clay, preground for 24 hr, combine to create a new lead of substantially greater point strength, smoothness, durability, blackness and opacity. One dozen leads are packaged in a blue styrene sleeve with slide of semiflexible white polyethylene. Lead pencils (12 to a box) also are manufactured.

Eagle Pencil Co., Inc., Danbury, Conn.

Circle 60 for Reader Service

DESIGN DATA

12 Mg 24.32		
20 Ca 40.08	21 Sc 45.10	22 Ti 47.90
38 Sr 87.63	39 Y 88.92	40 Zr 91.22

Ti Titanium

The following tables represent all major commercial titanium producers and melters. More information is presented than has been previously available in any one publication. The 51 commercial and alloyed titaniums listed in the tables are generally available in commercial quantities on order.

Tables are grouped by producer and are arranged in sequence: Unalloyed, Alpha Alloys, Beta Alloys and Alpha-Beta Combination Alloys.

Data compiled by Union Carbide Metals Co., Div. of Union Carbide Corp.

Alpha and Beta designations describe crystalline structure:

Alpha . . . hexagonal close-packed crystal (HCP)
Beta . . . body-centered cubic crystal (BCC)
Alpha-Beta . . . combined Alpha-Beta crystal

(Continued on next page)

SEEN AND HEARD

TITANIUM SHEDS ITS MYSTERY

Victor W. Wigotsky,
Eastern Editor

Although titanium was first discovered in 1791, it is only about 12 years that it has been produced commercially. Present annual consumption of mill products is now approximately 11,000,000 lb. While titanium's weight advantage, strength and superior corrosion characteristics in oxidizing environments are well-known, there are still some skeletons, with reference to the metal, which should be brought out of the closet and discarded.

Some of these originated because titanium emerged upon the engineering scene as an exotic metal, full of expectation, expense and mystery. No doubt it is time to take a close look at this industrial youth and see what it has to offer in terms of engineering advantages and cost.

Titanium costs more, but not as much as often believed. Prices of titanium have been declining steadily. In 1956, titanium alloy grade 6AL-4V billet sold for $7.45 per lb; bar for $7.75 per lb, and commercially pure plate for $10 per lb. Today, titanium alloy billet sells for $3 per lb; bar, $3.39, unalloyed plate, $4.45. It also should be realized, when comparing these prices with other metals being considered, that the lighter weight of titanium yields increased volume in parts per lb.

Another persistent problem relates to the abundance of "experts" on titanium. In its approximately 12-year industrial life, titanium often has evoked dramatic attention. Many individuals have seemed to move through industry with some working knowledge of titanium, which was often based on rapidly outdated information. Some 25 corporations and about a half-dozen government agencies have been involved in titanium's growth pains. Notwithstanding many pitfalls and discouragements, the fledgling metal has emerged with a sig-

(Continued on next page)

For Free Reprints of this Design Data Article, Circle 527 on Reader-Service Card

The table to the right cross-references producers, indicating comparable products.

The following producers are represented:

Tables 1-10
Crucible Steel Co. of America
P. O. Box 2518
Pittsburgh 30, Pa.

Tables 10-20; Table 51
Reactive Metals, Inc.
Niles, Ohio
(Formerly Mallory-Sharon Metals Corp.)

Tables 21-22
Oregon Metallurgical Corp.
P. O. Box 484
Albany, Ore.

Tables 23-33
Republic Steel Corp.
Republic Bldg.
Cleveland, Ohio

Tables 34-46
Titanium Metals Corp. of America
233 Broadway
New York 7, N. Y.

Tables 47-50
Harvey Aluminum
19200 South Western Ave.
Torrance, Calif.

UNALLOYED

CRUCIBLE	TABLE NO.	REACTIVE METALS	TABLE NO.	OREMET	TABLE NO.	REPUBLIC	TABLE NO.	TMCA	TABLE NO.	HARVEY	TABLE NO.
A 40	1	MST 40	11			RS 40	23	Ti 45A	34		
								Ti 55A	35		
A 55	2	MST 55	12			RS 55	24	Ti 65A	36		
A 70	3	MST 70	13			RS 70	25	Ti 75A	37	HA 1900	47
								Ti 100A	38		
				Cast C.P.Ti	21						

ALPHA ALLOYS

CRUCIBLE	TABLE NO.	REACTIVE METALS	TABLE NO.			REPUBLIC	TABLE NO.	TMCA	TABLE NO.	HARVEY	TABLE NO.
A 110 AT	4	MST 5A1 2.5Sn	14			RS 110C	26	Ti 5A1 2.5Sn	39	HA 5A1 2.5Sn	48
		MST 821	51								

BETA ALLOYS

CRUCIBLE	TABLE NO.					REPUBLIC	TABLE NO.	TMCA	TABLE NO.		
B 120 VCA	5					RS 120B	27	Ti 13V 11Cr 3A1	40		

ALPHA–BETA ALLOYS

CRUCIBLE	TABLE NO.	REACTIVE METALS	TABLE NO.	OREMET	TABLE NO.	REPUBLIC	TABLE NO.	TMCA	TABLE NO.	HARVEY	TABLE NO.
								Ti 140A	41		
C 110M	6	MST 8Mn	15			RS 110A	28				
C 115AMoV	7					RS 115	29	Ti 4A1 3Mo 1V	42		
C 130AM	8	MST 4A1 4Mn	16			RS 130	30				
		MST 3A1 5Cr	17								
								Ti 155A	43		
						RS 140	31				
C 120AV	9	MST 6A1 4V	18	Cast 6A1 4V	22	RS 120A	32	Ti 6A1 4V	44	HA 6148	49
										HA 6510	50
C 135AMo	10	MST 7A1 4Mo	19			RS 135	33	Ti 7A1 4Mo	45		
								Ti 8A1 1Mo 1V	46		
		MST 2.5A1 16V	20								

SEEN AND HEARD

nificant potential and a body of valid data which separates titanium facts from fancy. Organizations such as the Battelle Memorial Institute and titanium producers now can provide realistic assurance to the designer that titanium is no longer an industrial embryo.

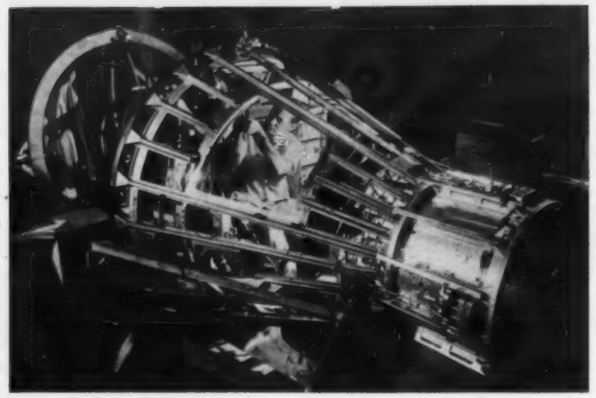
Whether or not titanium presents fabrication problems also brings varying responses. There are the too-casual optimists who say, "Everyone can fabricate titanium." At the extreme opposite is the school (now essentially dead) which holds that no one can fabricate it without inordinate cost and headache.

The fact is that titanium can be turned, milled, drilled, tapped and ground with essential similarity to stainless steel. The equipment manufacturer, however, is almost as important to the performance of a completed titanium assembly as the metal itself. He must be selected with care, to be certain that he is qualified to work with titanium. In general, titanium also usually will cost more to fabricate than "conventional" material, but not inordinately so. Whatever differential there is, however, is relative (considering the weight saving and/or corrosion immunity the metal offers) and of steadily narrowing scope. In such areas, titanium is going to be a tough runner to ignore.

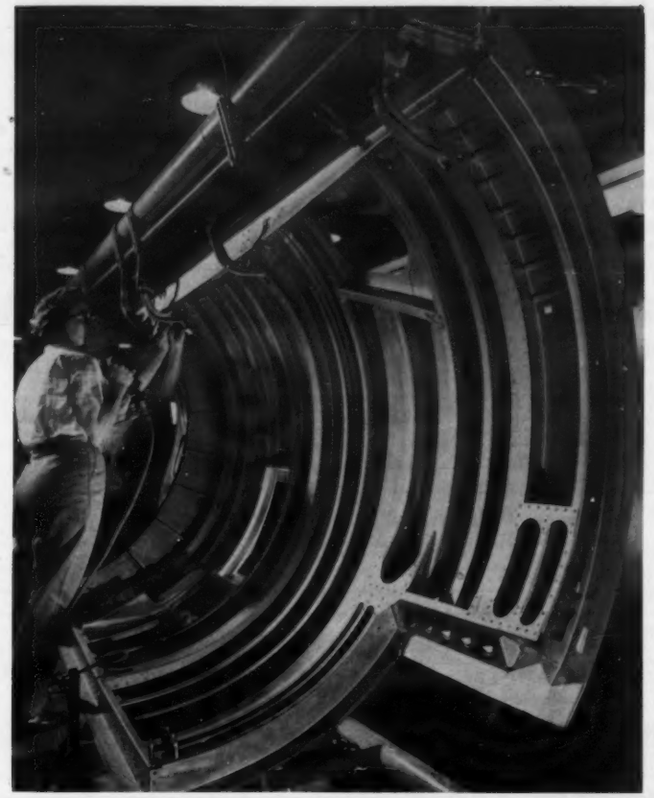
There have been many jokes about the buildup of piles of worn-out cutting tools alongside the finished titanium parts. This may have been true some years ago, but titanium machining has become a routine operation. Low cutting speeds, high feed rates, copious amounts of cutting fluids, use of sharp tools which should be replaced at the first sign of wear and rigid machine elements are basic requirements in machining titanium. This may sound like an oversimplification, but it does give some idea of the pragmatic solutions available. It is also significant to note that titanium can be machined after final heat treatment.

How about the facility of welding titanium? A great deal of experience has been accumulated concerning titanium welding. Titanium can be fusion-, resistance- and spot-welded. It is important, of course, to understand the characteristics of titanium for proper welding. More than 4000 welded vessels, operating under high pressure at cryogenic temperatures, have gone into service in the missile program. Solid rocket motor casings are welded, as are jet-engine parts which have given reliable service measured in multimillion hours. Welded titanium tubing has important potential in chemical process equipment. While titanium welding still often conjures up images of inert-gas chambers, much welding now is done in the open, using fairly simplified devices for supplying protective inert gas to the weld zone. Titanium welds also provide the same excellent resistance to corrosion as does the parent metal.

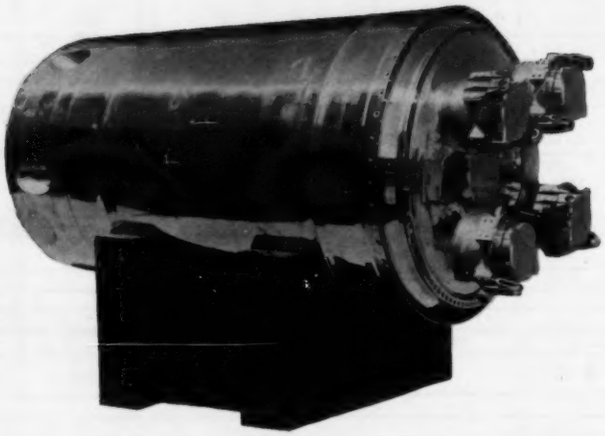
Titanium people always wince when the metal is described as "exotic". They prefer to think of it as tough, available, economical and backed up with a large body of data which can give the engineer and designer confidence in its use.



MERCURY CAPSULE uses all-titanium frame of hat-section stringers and machined rings.



TITANIUM ACCESS PANEL which covers engine in DC-8, complete with titanium details, measures 102 by 76 inches and weighs 80 lb. Cumulative tolerances are controlled so closely at Ryan that each door is interchangeable with any pod built for a specific airline. 600 lb of titanium (TMCA Ti-75A) are used in construction of DC-8 pods and pylons.



TITANIUM ROCKET CASE manufactured by Aerojet General Corp. from the Ti-6A1-4V alloy.

PLASTIC BAG filled with argon is used by Pratt & Whitney Aircraft in welding 5A1-2.5Sn low compressor case.

TITANIUM FOIL in widths up to 24 inches and thicknesses ranging from 0.000125 to 0.010 inch has potentialities in the electronic industry and in honeycomb sections.

Titanium . . . . .

DESIGNATION	A 40 TABLE 1				A 55 TABLE 2					
PRODUCER	Crucible Steel Company of America				Crucible Steel Company of America					
PRINCIPAL USES	Nonstructural, corrosion–resistant applications requiring maximum ductility and formability				Nonstructural aircraft parts; all types corrosion–resisting applications					
AVAILABLE FORMS	Sheet, strip, plate, tubing, billet, bar, wire				Sheet, strip, plate, tubing, billet, bar, wire					
NOMINAL COMPOSITION	Unalloyed				Unalloyed					
TYPE STRUCTURE	Alpha				Alpha					
MECHANICAL PROPERTIES	Temperature				Temperature					
	Room	400 F	600 F	800 F	Room	400 F	600 F	800 F	1000 F	–321 F
Ultimate Tensile Strength, psi	50,000 ①	37,000	28,400	24,800	65,000	50,000	39,000	33,000	22,000	155,000
Yield Strength, 0.2% offset, psi	40,000 ①	20,600	12,600	11,700	55,000	33,000	25,000	20,000	14,000	
Elongation in 2 inches, percent	22				18					32
Reduction of Area, percent	30				30					38
Impact, Charpy V, ft-lb					43					
Fatigue Strength, ( ) cycles, psi										
Bend Radius	1.5T ② 2.0T ③				2.0T ① 2.5T ④					
Welded Bend Radius										
Rockwell Hardness										
Rupture, Stress to produce in ( ) hr, psi						1000 hr 42,000	1000 hr 36,000	1000 hr 10,000	1000 hr 4,000	
Creep Data, Stress to produce ( ) percent elongation in ( ) hr, psi						1% 1000 hr 22,800	1% 1000 hr 15,000	1% 1000 hr 2,600		
PHYSICAL PROPERTIES										
Modulus of Elasticity, psi, (10^6) tension	15.5				15.5					
Modulus of Elasticity, psi, (10^6) torsion					6.5					
Density, lb/cu inch	0.163				0.163					
Melting Range, deg F	3135				3135					
Specific Electrical Resistivity micro ohms/cm/sq cm	(48.6) (10^{-6})				(48.6) (10^{-6})					
Specific Heat, Btu/lb/deg F	0.130				0.125					
Thermal Conductivity, Btu/hr/sq ft/deg F/ft	11.5				11.5					
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 212 F	4.8				4.8					
32 – 600 F	5.3				5.3					
32 – 1000F	5.5				5.5					
32 – 1200F	5.6				5.6					
32 – 1500F	5.8				5.8					
	400 F	600 F	800 F	1000 F	400 F	600 F	800 F	1000 F		
Oxidation Resistance in Air short time	Good	Good	Good	Moderate	Good	Good	Good	Moderate		
Oxidation Resistance in Air long time	Good	Good	Good	Moderate	Good	Good	Good	Moderate		
REMARKS ON FABRICATION										
Cutting	Requires heavy equipment and close adjustment of shear blades				Suitable – close adjustment of shear blade required					
Machining	Slow speed, heavy feed, rigid support, adequate coolant				Slow speed, heavy feed, rigid support, adequate coolant					
Forming	Suitable				Suitable					
Joining, Welding	Suitable – inert gas technique				Suitable – inert gas technique					
REMARKS ON HEAT TREATMENT										
Initial Forging	1550 – 1650 F				1550 – 1650 F					
Annealing	1100 – 1200 F				1100 – 1200 F					
Solution Treating	Not hardenable through thermal treatment				Not hardenable through thermal treatment					
Aging	Not hardenable through thermal treatment				Not hardenable through thermal treatment					
Stress Relief Annealing	850 – 950 F				850 – 950 F					
NOTES AND GENERAL REMARKS	① Minimum ② < 0.070 inch thick ③ 0.070 to 0.187 inch, inclusive				① < 0.070 inch thick ② 0.070 to 0.187 inch, inclusive					

	A 70 TABLE 3	A 110 AT TABLE 4	B 120 VCA TABLE 5
	Crucible Steel Company of America	Crucible Steel Company of America	Crucible Steel Company of America
	Moderately-stressed aircraft parts; corrosion-resisting applications requiring higher strength.	Parts requiring maximum strength in range 600 – 1100 F; high strength welded assemblies.	Pressure vessels requiring optimum strength-weight ratios; airframe members, stiffeners, missile casings, honeycomb panels, aircraft fasteners.
	Sheet, strip, plate, tubing, billet, bar, wire	Sheet, strip, plate, bar, billet, wire	Sheet, strip, wire, bar, billet, plate
	Unalloyed	5% Al, 2-1/2% Sn	13% V, 11% Cr, 3% Al
	Alpha	Alpha (close-packed hexagonal)	Beta

Temperature						Temperature							Temperature					
Room	400 F	600 F	800 F	1000 F	-321 F	Room	400 F	600 F	800 F	1000 F	-100 F	-321 F	Room	400 F	600 F	800 F	1000 F	-100 F
80,000	55,000	43,000	33,000	24,000	155,000	115,000 min	100,000	88,000	82,000	75,000	160,000	225,000	125,000	125,000	117,000	126,000	100,000	180,000
70,000	39,000	27,000	20,000	17,000		110,000 min	83,000	67,000	63,000	58,000	136,000		120,000	114,000	99,000	102,000	94,000	
15	28	28	20	80	24	10 min	17	16	15	18		13.5	10	23	24	17	37	
30	55	58	68	87	35	40	42	41	40	42		25	40					
10						19					18		8					
10^7 cycles 62,000						10^7 cycles 98,000							10^6 cycles 65,000					
2.5 T ①, 3.0 T ②						4.0 T ①, 4.5 T ②							3 T					
						R_c 30 – 35												
	1000 hr 44,000	1000 hr 32,000	1000 hr 16,000	1000 hr 5,000			1000 hr 76,000	1000 hr 65,000	1000 hr 58,000	1000 hr 20,000								
	1% 1000 hr 29,600	1% 1000 hr 19,200	1% 1000 hr 6,400	1% 1000 hr 1,600				0.5% 1000 hr 57,500		0.5% 1000 hr 36,000								

15.5	16.5	14.2
6.5		
0.163	0.163	0.175
3135	2822 – 3002	
(54.8) (10^{-6})	(157.3) (10^{-6})	
0.125	0.126	0.130
10.1	4.31	3.7
4.8	5.2	5.2
5.3	5.3	5.4
5.5	5.4	
5.6	5.5	
5.8	5.6	

400 F	600 F	800 F	1000 F	400 F	600 F	800 F	1000 F	400 F	600 F	800 F	1000 F
Good	Good	Good	Moderate	Good	Good	Good	Moderate	Good	Good	Good	Moderate
Good	Good	Good	Moderate	Good	Good	Good	Moderate	Good	Good	Good	Moderate

Suitable – close adjustment of shear blade recommended	Suitable – close adjustment of shear blade recommended	Suitable
Suitable – heavy feed, slow speed, adequate coolant	Suitable – heavy feed, slow speed, adequate coolant	Suitable
Suitable	Suitable	Suitable
Suitable – inert gas technique	Suitable – inert gas technique	Inert gas technique
1500 – 1650 F	1600 – 1900 F	1800 – 1850 F
1100 – 1200 F	1500 F	1400 F
Not hardenable through thermal treatment	Not hardenable through thermal treatment	Various
Not hardenable through thermal treatment	Not hardenable through thermal treatment	Various
850 – 950 F	1000 – 1200 F	
① < 0.070 inch thick ② 0.070 to 0.187 inch, inclusive	① < 0.070 inch thick ② 0.070 to 0.187 inch, inclusive	

Titanium . . . . .

DESIGNATION	C 110 M — TABLE 6					C 115 AMoV — TABLE 7					C 130 AM — TABLE 8				
PRODUCER	Crucible Steel Company of America					Crucible Steel Company of America					Crucible Steel Company of America				
PRINCIPAL USES	Aircraft skins and structural members in aircraft applications					Aircraft sheet application					High strength airframe forgings, fasteners, compressor parts and industrial equipment requiring maximum strength with good corrosion resistance				
AVAILABLE FORMS	Sheet, plate					Sheet					Billet, bar, forgings, plate, wire				
NOMINAL COMPOSITION	8% Mn					4% Al, 3% Mo, 1% V					4% Al, 4% Mn				
TYPE STRUCTURE	Alpha–beta					Alpha–beta					Alpha–beta				
MECHANICAL PROPERTIES	Temperature					Temperature					Temperature				
	Room	400 F	600 F	800 F	1000 F	Room	400 F	600 F	800 F	1000 F	Room	400 F	600 F	800 F	1000 F
Ultimate Tensile Strength, psi	120,000	106,000	98,000	87,000	42,000	125,000	145,000	135,000	120,000	100,000	140,000	130,000	122,000	108,000	72,000
Yield Strength, 0.2% offset, psi	110,000	78,000	70,000	63,000	35,000	115,000	110,000	100,000	95,000	82,000	130,000	112,000	100,000	88,000	51,000
Elongation in 2 inches, percent	10	18	18	20	32	11	7	7	10	15	10	19 ①	20 ①	24 ①	41 ①
Reduction of Area, percent	32	38	36	48	78						25	45	52	62	85
Impact, Charpy V, ft-lb											16				
Fatigue Strength, ( ) cycles, psi	10^7 cycles 88,000										10^7 cycles 90,000				
Bend Radius	3T ①, 3.5T ②					3.5T ①, 4T ②									
Welded Bend Radius															
Rockwell Hardness															
Rupture, Stress to produce in ( ) hr, psi		1000 hr 100,000	1000 hr 91,000	1000 hr 26,000								1000 hr 110,000	1000 hr 95,000	1000 hr 46,500	
Creep Data, Stress to produce ( ) percent elongation in ( ) hr, psi		1% 1000 hr 71,000	1% 1000 hr 62,500	1% 1000 hr 20,400											
PHYSICAL PROPERTIES															
Modulus of Elasticity, psi, (10^6) tension	16.4										16.6				
Modulus of Elasticity, psi, (10^6) torsion															
Density, lb/cu inch	0.171					0.161					0.163				
Melting Range, deg F	2730 – 2970										2822 – 3002				
Specific Electrical Resistivity micro ohms/cm/sq cm	(90.7) (10^{-6})										(146.1) (10^{-6})				
Specific Heat, Btu/lb/deg F	0.118										0.129				
Thermal Conductivity, Btu/hr/sq ft/degF/ft	6.3										4.0				
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 212 F	4.8										4.9				
32 – 600 F	5.4										5.1				
32 – 1000F	6.0										5.4				
32 – 1200F	6.5										5.6				
32 – 1500F	7.1										5.7				
Oxidation Resistance in Air	400 F	600 F	800 F	1000 F							400 F	600 F	800 F	1000 F	
short time	Good	Good	Good	Moderate							Good	Good	Good	Moderate	
long time	Good	Good	Good	Moderate							Good	Good	Good	Moderate	
REMARKS ON FABRICATION															
Cutting	Material thicker than 0.070, shear or punch at 250 – 500 F					Suitable					Suitable				
Machining	Suitable – heavy feed, slow speed, adequate coolant					Suitable					Suitable – slow speed, heavy feed, adequate coolant				
Forming	Suitable					Suitable (cold)					Not sheet alloy				
Joining, Welding	Not recommended for welded assemblies					Not recommended for welded assemblies					Not recommended for welded assemblies				
REMARKS ON HEAT TREATMENT															
Initial Forging	Not forging alloy					Sheet alloy only					1650 – 1750 F				
Annealing	1300 F slow cool to 100 F, then air cool					1500 – 1675 F					1300 F				
Solution Treating	1 to 2 hr, 1300 – 1400 F					1500 – 1675 F					1450 F, water quench				
Aging	2 to 4 hr, 1000 F					Various					900 F, 8 hr				
Stress Relief Annealing	1100 F										1100 F				
NOTES AND GENERAL REMARKS	① < 0.070 inch thick ② 0.070 to 0.187 inch, inclusive					① < 0.070 inch thick ② 0.070 to 0.187 inch, inclusive					① In 1 inch				

C 120 AV — TABLE 9						
Crucible Steel Company of America						
Jet engine compressor parts, medium–high strength airframe forgings, special ordnance equipment						
Sheet, strip ,plate, billet, bar, wire						
6% Al, 4% V						
Alpha–Beta						
	Temperature					
Room	400 F	600 F	800 F	1000 F	–100 F	–321 F
130,000	120,000	115,000	105,000	90,000	155,000	240,000
120,000	110,000	100,000	92,000	68,000	141,000	
10						10
25						30
20						
10^7 cycles 78,000						
	1000 hr 95,000	1000 hr 78,000	1000 hr 50,000	1000 hr 10,000		
		0.55% 1000 hr 60,000				
15.8						
0.163						
2786–2976						
176						
0.135						
3.8						
4.8						
5.1						
5.3						
5.5						
5.7						
400 F	600 F	800 F	1000 F			
Good	Good	Good	Moderate			
Good	Good	Good	Moderate			
Suitable						
Suitable–slow speed; heavy feeds, adequate coolant						
Suitable						
More suitable than other alpha–beta, but ductility of welded joint relatively low						
1700–1750 F						
1350 F						
1500–1600F, 1 to 2 hrs						
4 to 8 hr, 900 F						
1000–1200 F						

C 135 AMo — TABLE 10				
Crucible Steel Company of America				
Jet engine compressor parts, high–stress missile and airframe forgings, special ordnance equipment				
Bar, billet, forgings				
7% Al, 4% Mo				
Alpha–Beta				
	Temperature			
Room	400 F	800 F	1000 F	
140,000	133,000	118,000	102,000	
135,000	121,000		97,000	
10				
20				
15				
10^7 cycles 95,000				
16.2				
0.163				
175				
0.123				
3.7				
4.92				
400 F	600 F	800 F	1000 F	
Good	Good	Good	Moderate	
Good	Good	Good	Moderate	
Suitable				
Suitable–slow speed; heavy feeds, adequate coolant				
Not available in sheet form				
Not recommended for welded assemblies				
1700–1800 F				
1450 F, slow cool to 1250 F, then air cool				
1750 F, water quench				
1150 F				
1100 F				

MST 40 — TABLE 11				
Mallory–Sharon Metals Corporation				
Corrosion–resistant parts for chemical, plating, food processing industries; aircraft parts requiring high formability				
Sheet, strip, plate, bar, billet, wire, tubing				
0.10% max C, 0.0150% max H, 0.60% max other				
Alpha				
	Temperature			
Room	400 F	600 F	800 F	–100 F
60,000	37,000	28,400	24,800	78,000
50,000	20,600	12,600	11,700	48,500
25				
45				
10^7 cycles ① 21,000				
1.5T				
2.5				
15.5				
0.164				
3100				
45				
0.12				
12				
4.95				
5.3				
5.4				
5.6				
400 F	600 F	800 F	1000 F	
Good	Good	Good	Moderate	
Good	Good	Moderate	Moderate	
Friction sawing with lineal speed ≤ 4500 fpm				
Similar to 18–8 stainless steel				
Most readily formable type				
Inert gas shielded arc method				
1450–1700 F				
1350 F				
700–1000 F				
① Notched – Kt = 3.0				
Excellent tubing material; practically inert in salt water or other wet chlorides. Suitable for systems for recovery of fresh from saline water.				

Titanium . . . . .

DESIGNATION	MST 55 — TABLE 12						MST 70 — TABLE 13				
PRODUCER	Mallory–Sharon Metals Corporation						Mallory–Sharon Metals Corporation				
PRINCIPAL USES	Same as MST 40						Engine shrouds, fire seals, ammunition boxes, cowlings, chemical equipment				
AVAILABLE FORMS	Sheet, strip, plate, bar, billet, wire, tubing						Sheet, strip, plate, bar, billet, wire, tubing				
NOMINAL COMPOSITION	0.10% max C, 0.0150% max H, 0.60% max other elements						0.10% max C, 0.0150% max H, 0.80% max other elements				
TYPE STRUCTURE	Alpha						Alpha				
MECHANICAL PROPERTIES	Temperature						Temperature				
	Room	400 F	600 F	800 F	1000 F	–100 F	Room	400 F	600 F	800 F	1000 F
Ultimate Tensile Strength, psi	80,000	50,000	39,000	33,000	22,000	100,000	95,000	52,000	40,000	31,000	25,000
Yield Strength, 0.2% offset, psi	67,000	33,000	25,000	20,000	14,000	74,000	80,000	36,000	24,000	21,000	17,000
Elongation in 2 inches, percent	22						20	27	30	28	62
Reduction of Area, percent	45						45	55	62	72	83
Impact, Charpy V, ft-lb	40						12				
Fatigue Strength, ( ) cycles, psi	10^7 cycles ① 30,000						10^7 cycles ① 60,000				
Bend Radius	2.0 T						3.0 T				
Welded Bend Radius	3.0						4.0 T				
Rockwell Hardness											
Rupture, Stress to produce in ( ) hr, psi	1000 hr 58,000		1000 hr 25,000	1000 hr 10,000	1000 hr 4000		1000 hr 66,000		1000 hr 40,000	1000 hr 14,000	1000 hr 5,000
Creep Data, Stress to produce ( ) percent elongation in ( ) hr, psi	1% 1000 hr 34,000		1% 1000 hr 11,000	1% 1000 hr 2,000			1% 1000 hr 40,000		1% 1000 hr 28,000	1% 1000 hr 8,000	
PHYSICAL PROPERTIES											
Modulus of Elasticity, psi, (10^6) tension	15.5						15.5				
Modulus of Elasticity, psi, (10^6) torsion											
Density, lb/cu inch	0.164						0.164				
Melting Range, deg F	3100						3100				
Specific Electrical Resistivity micro ohms/cm/sq cm	48.6						55.5				
Specific Heat, Btu/lb/deg F	0.12						0.12				
Thermal Conductivity, Btu/hr/sq ft/degF/ft	11.5						9.9				
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 212 F							4.95				
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 600 F	4.95						5.3				
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 1000F	5.3						5.4				
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 1200F	5.4						5.6				
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 1500F	5.6										
Oxidation Resistance in Air	400 F	600 F	800 F		1000 F		400 F	600 F	800 F		1000 F
Oxidation Resistance in Air — short time	Good	Good	Good		Moderate		Good	Good	Good		Moderate
Oxidation Resistance in Air — long time	Good	Good	Moderate		Moderate		Good	Good	Moderate		Moderate
REMARKS ON FABRICATION											
Cutting	Friction sawing with lineal speed of about 4500 fpm						Friction sawing with lineal speed of at least 4500 fpm				
Machining	Similar to 18–8 stainless steel						Similar to 18–8 stainless steel				
Forming	Form at room temperature if severe flanges are not required						Form at room temperature if severe flanges are not required				
Joining, Welding	Inert gas shielded arc method						Inert gas shielded arc method				
REMARKS ON HEAT TREATMENT											
Initial Forging	1600–1700 F						1600–1700 F				
Annealing	1350 F; 1/2 hr; air cool						1350 F; 1/2 hr; air cool				
Solution Treating											
Aging											
Stress Relief Annealing	1000 F; 20 minutes; air cool						1000 F; 20 minutes; air cool				
NOTES AND GENERAL REMARKS	Used in aircraft parts where greater formability and less strength are required than with MST 70. MST 55 is commercially pure grade most widely used in chemical processes and related industries because of moderate strength and good formability. ① Notched – Kt = 3.0						Commercially pure titanium easier to form and machine than titanium alloys. Not recommended for use in tubing form where bending or welding required. ① Unnotched; 35,000 psi for notched – Kt = 3.0				

MST 5 Al 2.5 Sn — TABLE 14					MST 821	MST 8 Mn — TABLE 15					MST 4 Al 4 Mn — TABLE 16						
Mallory–Sharon Metals Corporation						Mallory–Sharon Metals Corporation					Mallory–Sharon Metals Corporation						
Tail cones, shroud spacers, stiffeners, high-strength fusion welded assemblies						Aircraft firewalls, stiffeners, bulkheads					Airframe and engine forgings, aircraft fasteners						
Sheet, strip, plate, bar, billet, wire						Sheet, strip					Bar, billet wire						
4.5–5.5% Al, 2.0–3.0% Sn						6.0–9.0% Mn					3.0–5.0% Mn, 3.0–5.0% Al						
Alpha						Alpha–Beta					Alpha–Beta						
Temperature						Temperature					Temperature						
Room	400 F	600 F	800 F	1000 F		Room	400 F	600 F	800 F	1000 F	Room	400 F	600 F	800 F	1000 F	–100 F	–321 F
120,000	100,000	90,000	83,000	78,000		140,000	118,000	110,000	98,000	73,000	150,000 ①	118,000	111,000	99,000	73,000	172,000	256,000
11,500	83,000	69,000	63,000	59,000		130,000	103,000	90,000	78,000	52,000	190,000 ②	102,000	90,000	76,000	52,000	169,000	254,000
13	17	17	17	19		15	18	18	22	40	15 ③	17	18	22	40	19.6	2.1
30	40	40	40	42		30	44	45	48	65	35 ④	43	45	48	65	2.1	4.9
14											12					5.7	2.6
10^7 cycles ① 76,000						10^7 cycles ① 63,000					10^7 cycles 90,000 ⑤⑥						
4.5 T						3.0 T											
R_c 32											R_c 35						
			1000 hr 34,000 ②	1000 hr 18,000		1000 hr 120,000		1000 hr 116,000	1000 hr 21,000		1000 hr 137,000	1000 hr 118,000	1000 hr 105,000	1000 hr 48,000			
			1% ③ 1000 hr 48,000	1% 1000 hr 6,000		1% 1000 hr 110,000		1% 1000 hr 55,000	1% 1000 hr 9,000		1% 1000 hr 115,000	1% 1000 hr 98,000	1% 1000 hr 78,000	1% 1000 hr 37,000			
16						16					16						
0.161						0.172					0.163						
3400						3200					3000–3100						
158						88					146.1						
125						0.140					0.130						
4.85 at 200F						6.5					4.0						
5.2																	
5.3											5.1						
5.4											5.4						
5.5						4.99					5.6						
5.6											5.75						
						400 F	600 F	800 F	1000 F		400 F	600 F	800 F	1000 F			
						Excellent	Good	Good	Good		Good	Good	Good	Good			
						Excellent	Good	Good	Good		Good	Good	Good	Moderate			
Positive feed (heavy as possible), slow speed											Positive feed (heavy as possible), slow speed						
Rigid set–up, heavy feed, slow speed, sharp tool											Rigid set–up, heavy feed, slow speed, sharp tool						
Generally, hot forming required (600–1200F)						Hot forming for intricate shapes (600–1000F)											
Fusion welding, inert-gas, stress relief, 1000–1150F																	
1700–2000F						1700F					1650F ± 25F						
1300–1500F						1200F, fast cool to 900F, air cool					1300F, 1 hr, air cool						
											1450F, 1 hr, water quench						
											800F, 8 hr, air cool						
1150F						1000F, 1/2 hr, air cool					1000F, 1/2 hr, air cool						
Alloy offers good resistance to creep at temperature in the 600–800F range, and short time temperature strengths up to 1000F. ① Unnotched. ② 900F ③ At 900F, 1 pct, 1000 hr: 16,000						This sheet alloy is intended for use in medium temperature range of 400–800F where elevated temperature strength above that of commercially pure grades is needed. Alloy is readily formable into intricate shapes and is proved to be dependable alloy for airframe shrouding, stiffeners and bulkheads. ① Unnotched.					Alloy is satisfactory where good weld ductility is not needed. ① Fasteners, aged: 165,000 ② Fasteners, aged: 158,000 ③ Aged: 14 ④ Fasteners, aged: 35 ⑤ Unnotched ⑥ Aged, unnotched: 10^7 cycles: 106,000						

SEE CHART NUMBER 51

SEE CHART NUMBER 51

Titanium . . . . .

DESIGNATION	MST 3 A1 5 Cr TABLE 17					MST 6 A1 4 V TABLE 18					MST 7 A1 4 Mo TABLE 19				
PRODUCER	Mallory–Sharon Metals Corporation					Mallory–Sharon Metals Corporation					Mallory–Sharon Metals Corporation				
PRINCIPAL USES	Airframe forgings and fasteners					Fasteners, forgings, engine shrouds, cowlings; compressor blades, discs, spacers, ring and extrusions, marine shafting, struts, propellers, hydrofoils, lawn mower blades.					Compressor blades and spacers for jet engines				
AVAILABLE FORMS	Bar, billet					Sheet, bar, strip, plate, billet, wire					Plate, bar, billet, wire				
NOMINAL COMPOSITION	3% A1, 5% Cr					5.5–6.5% A1, 3.5–4.5% V					6.5–7.5% A1, 3.5–4.5% Mo				
TYPE STRUCTURE	Alpha–Beta					Alpha–Beta					Alpha–Beta				
MECHANICAL PROPERTIES	Temperature					Temperature					Temperature				
	Room	400 F	600 F	800 F	1000 F	Room	400 F	600 F	800 F	1000 F	Room	400 F	600 F	800 F	1000 F
Ultimate Tensile Strength, psi	155,000	130,000	116,000	110,000	75,000	136,000 ①	140,000	128,000	120,000	100,000	160,000 ①	139,000	123,000	115,000	102,000
Yield Strength, 0.2% offset, psi	145,000	104,000	87,000	76,000	35,000	128,000 ②	120,000	104,000	85,000	56,000	150,000 ②	121,000	108,000	97,000	82,000
Elongation in 2 inches, percent	13	21	22	24	38	16 ③	17	15	17	30	15 ③	14	17	17	19
Reduction of Area, percent	35	69	72	81	96	38 ④	55	60	68	85	30 ④	40	45	47	53
Impact, Charpy V, ft-lb	20					18 ⑤					16–20				
Fatigue Strength, ( ) cycles, psi	10^8 cycles 85,000 ①					10^7 cycles ⑥ 78,000 ⑦					10^7 cycles 93,000 ⑤				
Bend Radius						4.57									
Welded Bend Radius															
Rockwell Hardness	R_c 32					R_c 32									
Rupture, Stress to produce in ( ) hr, psi								1000 hr ⑧ 95,000	1000 hr 75,000	1000 hr ⑨ 50,000					
Creep Data, Stress to produce ( ) percent elongation in ( ) hr, psi									1% 1000 hr 32,000	1% ⑩ 1000 hr 3,000			0.1% 1000 hr 88,000	0.1% 1000 hr 14,000	0.1% 1000 hr 2,000
PHYSICAL PROPERTIES															
Modulus of Elasticity, psi, (10^6) tension	16					16.5					16				
Modulus of Elasticity, psi, (10^6) torsion						6									
Density, lb/cu inch	0.166					0.160					0.163				
Melting Range, deg F	3000–3100					3100					3400				
Specific Electrical Resistivity micro ohms/cm/sq cm	150					176									
Specific Heat, Btu/lb/deg F						0.132									
Thermal Conductivity, Btu/hr/sq ft/degF/ft						3.7									
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 212 F						4.8									
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 600 F						5.1									
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 1000F						5.3									
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 1200F						5.5									
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 1500F	6.1														
Oxidation Resistance in Air	400 F	600 F	800 F	1000 F		400 F	600 F	800 F	1000 F						
Oxidation Resistance in Air short time	Good	Good	Good	Good		Excellent	Good	Good	Good						
Oxidation Resistance in Air long time	Good	Good	Good	Moderate		Excellent	Good	Good	Good						
REMARKS ON FABRICATION															
Cutting	Positive feed (heavy as possible), slow speed					Positive feed (heavy as possible), slow speed					Positive feed (heavy as possible), slow speed				
Machining	Rigid set–up, heavy feed, slow speed, sharp tool					Rigid set–up, heavy feed, slow speed, sharp tool					Rigid set–up, heavy feed, slow speed, sharp tool				
Forming						Generally, hot forming required									
Joining, Welding						Fusion welding with inert gas and stress relief									
REMARKS ON HEAT TREATMENT															
Initial Forging	1600–1650 F					1750 F maximum furnace temperature					1600–1800 F				
Annealing	1350 F, 1/2 hour, air cool					1300 F, 2 hr, air cool					1350–1550 F				
Solution Treating						1700 F ± 50 F, 1 hr ± 1/2 hr, immediate water quench					1600–1700 F , 1 hr, water quench				
Aging						900–1100 F, 2 to 16 hr, air cool					950–1150 F, 6 hr, air cool				
Stress Relief Annealing	700F, 1/2 hour, air cool					1000 F, 1/2 hr, air cool					1150–1250 F				
NOTES AND GENERAL REMARKS	Extensive R & D work indicates good possible landing gear material, and for use in gears. ① Unnotched					Considerable potential for missile pressure vessels. ① Aged: 165,000 ② Aged: 155,000 ③ Aged: 12 ④ Aged: 34 ⑤ Aged: 14 ⑥ Unnotched ⑦ Aged; unnotched: 10^7 cycles 97,000 ⑧ 700F ⑨ 900F ⑩ For 900F, 13,000 psi					Alloy possesses excellent creep strength and can be used at temperatures up to 800 F for long times or 1300 F for short times. ① Aged: 190,000 ② Aged: 175,000 ③ Aged: 12 ④ Aged: 20 ⑤ Unnotched				

MST 2.5 A1 16 V TABLE 20				
Mallory–Sharon Metals Corporation				
Airframe skins, web, angles and shrouds				
Sheet, strip, plate				
2.5% A1, 16% V				
Alpha–Beta				
Temperature				
Room	400 F ⑤	600 F ⑤	800 F ⑤	1000F ⑤
105,000 ①②	150,000	145,000	130,000	60,000
60,000 ②③	135,000	130,000	100,000	40,000
14 ①④	5	5	10	50
3.5T ①				
			4.8% 165 hr 50,000	
15 ⑤				
0.166 ⑤				
3100 ⑤				
134 ⑤				
0.132 ⑤				
4.7 ⑤				
4.99				
400 F	600 F	800 F	1000 F	
Excellent	Good	Good	Good	
Excellent	Good	Good	Good	
Positive feed (heavy as possible), slow speed				
Rigid set–up, heavy feed, slow speed, sharp tool				
Form in solution-treated condition and age				
Fusion welding with inert gas, stress relieve				
1380–1400 F, 1/2 hr, water quench				
925–975 F, 4 hr, air cool				
Possesses high tensile and bend ductility with large spread between UTS and YS in solution-treated condition. After forming in soft condition, alloy is capable of heat treatment to high strength. ① Solution treated ② Aged: 175,000 ③ Aged: 160,000 ④ Aged: 6 ⑤ Aged				

Cast CP Ti TABLE 21			
Oregon Metallurgical Corporation			
Corrosion–resisting applications			
Castings			
Unalloyed			
Alpha			
Temperature			
Room			
85,000 cast			
70,000 cast			
10 cast			
25			
Brinell 197			
15.5			
0.163			
3135			
(48.6) (10^{-3})			
0.125			
11.5			
4.7			
5.3			
5.5			
5.6			
5.8			
400 F	600 F	800 F	1000 F
Good	Good	Good	Good
Good	Good	Good	Good

Titanium . . . . .

DESIGNATION	RS 55 TABLE 24					RS 70 TABLE 25					RS 110C TABLE 26				
PRODUCER	Republic Steel Corporation					Republic Steel Corporation					Republic Steel Corporation				
PRINCIPAL USES	Airframe skins and firewalls, heat exchangers, marine hardware, chemical and food processing equipment, anodizing clips.					Airframe skins and firewalls, chemical plant valves and equipment piping, anodizing tanks, racks, clips, surgical prosthesis									
AVAILABLE FORMS	Sheet, strip, plate, bar, billet, wire, welded tubing					Sheet, strip, plate, billet, bar, wire, welded tubing					Sheet, strip, plate, bar, billet, wire				
NOMINAL COMPOSITION	0.10% max C, 0.05% max N					0.10% max C, 0.05% max N					0.10% max C, 0.05% max N, 5.0% Al 2.5% Sn				
TYPE STRUCTURE	Alpha					Alpha					Alpha				
MECHANICAL PROPERTIES	Temperature					Temperature					Temperature				
	Room ①	400 F ①	600 F ①	800 F ①	1000 F ①	Room ①	400 F ①	600 F ①	800 F ①	1000 F ①	Room ①	400 F ①	600 F ①	800 F ①	1000 F ①
Ultimate Tensile Strength, psi	65,000	37,000	28,000	25,000	20,000	80,000	62,000	55,000	52,000	40,000	115,000	92,000	75,000	70,000	66,000
Yield Strength, 0.2% offset, psi	55,000	27,000	21,000	21,000	15,000	70,000	47,000	40,000	35,000	26,000	110,000	85,000	67,000	57,000	42,000
Elongation in 2 inches, percent	18	39	32	20	22	15	30	32	27	35	10	20	21	18	22
Reduction of Area, percent															
Impact, Charpy V, ft-lb	20–35 at 70 F					15–20 at 70 F									
Fatigue Strength, ( ) cycles, psi															
Bend Radius	2T ② 2.5T ③					2.5T ② 3T ③					4T ② 4.5T ③				
Welded Bend Radius															
Rockwell Hardness	R_B 84–92					R_B 92–100					R_C 32–38				
Rupture, Stress to produce in ( ) hr, psi															
Creep Data, Stress to produce ( ) percent elongation in ( ) hr, psi															
PHYSICAL PROPERTIES															
Modulus of Elasticity, psi, (10^6) tension	15					15									
Modulus of Elasticity, psi, (10^6) torsion															
Density, lb/cu inch	0.163					0.163					0.161				
Melting Range, deg F															
Specific Electrical Resistivity micro ohms/cm/sq cm	60					60									
Specific Heat, Btu/lb/deg F	0.13 (approximate)					0.123					0.128				
Thermal Conductivity, Btu/hr/sq ft/deg F/ft	9.9					9.9					4.5				
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 212 F	4.7					4.7					5.2				
32 – 600 F															
32 – 1000 F															
32 – 1200 F															
32 – 1500 F															
Oxidation Resistance in Air	400 F	600 F	800 F	1000 F		400 F	600 F	800 F	1000 F		400 F	600 F	800 F	1000 F	
short time	Good	Good	Good	Moderate		Good	Good	Good	Moderate		Good	Good	Good	Moderate	
long time	Good	Good	Moderate	Poor		Good	Good	Moderate	Poor		Good	Good	Moderate	Poor	
REMARKS ON FABRICATION															
Cutting	Sharp tooling, maintain proper clearances					Sharp tooling required–maintain proper clearances					Satisfactory				
Machining	Suitable–rigid set–up, positive feed, sharp tool					Suitable–requires rigid set–up, positive feed, sharp tool					Suitable				
Forming	Good–elevated temp. may be required for severe forming					Good–elevated temp. may be req. for mod. severe forming					Most difficult– high temperature required				
Joining, Welding	Good					Good					Good				
REMARKS ON HEAT TREATMENT															
Initial Forging	1200–1600 F					1300–1700 F					1500–1950 F				
Annealing	1250 F, air cool					1250 F, air cool					1500 F, air cool				
Solution Treating	Not recommended					Not recommended					Not recommended				
Aging	Not recommended					Not recommended									
Stress Relief Annealing	1000 F					1000 F					1100 F				
NOTES AND GENERAL REMARKS	① All mechanical property values are nominal ② < 0.070 inch thick ③ 0.070 to 0.187 inch, inclusive					① All mechanical property values are nominal ② < 0.070 inch thick ③ 0.070 to 0.187 inch, inclusive					① All mechanical property values are nominal ② < 0.070 inch thick ③ 0.070 to 0.187 inch, inclusive				

RS 120 B TABLE 27	RS 110A TABLE 28	RS 115 TABLE 29	RS 130 TABLE 30
Republic Steel Corporation	Republic Steel Corporation	Republic Steel Corporation	Republic Steel Corporation
Airframe and missile structural components, aircraft engine parts, rocket motor cases	Airframe structural members, skins	Airframe components	Aircraft fasteners, airframe forgings
Sheet, strip, plate, bar, billet, wire	Sheet, strip, plate	Sheet, strip, plate	Plate, bar, billet, wire
0.10% max C, 0.05% max N, 13% V, 11% Cr, 3% Al	0.10% max C, 0.05% max N, 8.0% Mn	0.10% max C, 0.050% max N, 4% Al, 3% Mo, 1% V	0.10% max C, 0.05% max N, 4% Al, 4% Mn
Beta	Alpha–Beta	Alpha–Beta	Alpha–Beta
Temperature	**Temperature**	**Temperature**	**Temperature**
Room ①	Room ① / 400 F① / 600 F① / 800 F① / 1000 F①	Room ①	Room ①
130,000 ②	120,000 / 117,000 / 106,000 / 93,000 / 70,000	125,000 ②	140,000
120,000 ③	110,000 / 100,000 / 90,000 / 76,000 / 60,000	115,000 ③	130,000
10 ④	10 / 14 / 11 / 17 / 42	10	10
			25
			10–15 at 70 F
3T ⑤ 3.5T ⑥	3T② 3.5T③	3.5T ④ 4T ⑤	
R_c 26–32	R_c 28–34		R_c 30–36
14.2	15		16
0.175	0.172		0.163
	94		
0.131	0.118		0.128
	6.3		4.0
5.2	4.8		4.8
400F / 600F / 800F / 1000F	400 F / 600 F / 800 F / 1000 F	400 F / 600 F / 800 F / 1000 F	400 F / 600 F / 800 F / 1000 F
Good / Good / Good / Good	Good / Good / Good / Moderate	Good / Good / Good / Moderate	Good / Good / Good / Moderate
Good / Good / Good / Moderate	Good / Good / Moderate / Poor	Good / Good / Moderate / Poor	Good / Good / Moderate / Poor
Satisfactory	Satisfactory	Satisfactory	Satisfactory
Rigid set–up, pos. feed, sharp tool	Suitable	Suitable	Rigid set–up, positive feed, sharp tool
Room temperature	Simple–room temperature, complex–elevated temp	Room temperature ⑥	
Good	Not recommended	No data	Not recommended
1650–1950F	1300F–1700F	1500–1800F	1450 F–1750%
1450F, air cool	1250 F, slow cool	1300F, air cool	1450 F, slow cool
1450F, air cool	Not recommended	1635–1675F, water quench	Not recommended
900F	Not recommended	1050F, 6 hr, air cool	
1000–1100F	1000 F	1000–1100F	1100 F
① All mechanical properties nominal ② Aged: 190,000 ③ Aged: 170,000 ④ Aged: 4 ⑤ < 0.070 inch thick ⑥ 0.070 to 0.187 inch thick	① All mechanical property values nominal ② < 0.070 inch thick ③ 0.070 to 0.187 inch, inclusive.	High strength sheet alloy. Supplied in annealed, solution–treated, and solution–treated and aged conditions. ① All mechanical property values nominal. ② Aged : 170–195,000 ③ Aged: 150,000 ④ < 0.070 inch thick ⑤ 0.070 to 0.187 inch inclusive ⑥ Approximates RS110A in solution treated condition.	Moderately high strength bar and forging grade ① All mechanical property values are nominal.

Titanium . . . . .

DESIGNATION	RS 140 TABLE 31						RS 120A TABLE 32					RS 135 TABLE 33			
PRODUCER	Republic Steel Corporation						Republic Steel Corporation					Republic Steel Corporation			
PRINCIPAL USES	Airframe components						Airframe structural components as sheet, forgings, machined fittings					Aircraft frame and engine (turbojet) components			
AVAILABLE FORMS	Sheet, plate, strip, billet, bar, wire, foil						Sheet, strip, plate, bar, billet, wire					Billet, bar, plate, wire			
NOMINAL COMPOSITION	0.10% max C, 0.05% max N, 5.0% Al, 1.25% Fe, 2.75% Cr						0.10% max C, 0.05% max N, 6.0% Al, 4.0% V					0.10% max C, 0.05% max N, 7.0% Al, 4.0% Mo			
TYPE STRUCTURE	Alpha–Beta						Alpha–Beta					Alpha–Beta			
MECHANICAL PROPERTIES	Temperature						Temperature					Temperature			
	Room ①	400 F ①	600 F ①	800 F ①	1000 F ①	–321 F ①	Room ①	400 F ①	600 F ①	800 F ①	1000 F ①	Room ①	600 F ①	800 F ①	1000 F ①
Ultimate Tensile Strength, psi	150,000	130,000	115,000	108,000	82,000	244,000	130,000 ②	117,000	106,000	101,000	86,000	150,000 ②	118,000	112,000	100,000
Yield Strength, 0.2% offset, psi	140,000	117,000	105,000	92,000	70,000	234,000	120,000 ③	103,000	96,000	90,000	75,000	140,000 ③	103,000	97,000	85,000
Elongation in 2 inches, percent	10	13	11	15	30	14	10 ④	18	14.5	15	27	14 ④	20	19	22
Reduction of Area, percent	25					18	25 ⑤					45 ⑤	59	63	75
Impact, Charpy V, ft-lb	10–15 at 70 F					7–9	10–20 at 70 F					12–20 at 70 F			
Fatigue Strength, ( ) cycles, psi	10^8 cycles 92,000 ②														
Bend Radius	4T ③ 4.5T ④						4T ⑥ 4.5T ⑦ ⑧								
Welded Bend Radius															
Rockwell Hardness	R_C 32–38						R_C 30–38					R_C 32–38			
Rupture, Stress to produce in ( ) hr, psi														500 hr 95,000 ⑥	500 hr 41,000 ⑦
Creep Data, Stress to produce ( ) percent elongation in ( ) hr, psi															
PHYSICAL PROPERTIES															
Modulus of Elasticity, psi, (10^6) tension / torsion	16.5						16.5								
Density, lb/cu inch	0.163						0.160					0.162			
Melting Range, deg F															
Specific Electrical Resistivity micro ohms/cm/sq cm															
Specific Heat, Btu/lb/deg F															
Thermal Conductivity, Btu/hr/sq ft/degF/ft															
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 212 F							4.6								
32 – 600 F															
32 – 1000F															
32 – 1200F															
32 – 1500F															
Oxidation Resistance in Air	400 F	600 F	800 F	1000 F			400 F	600 F	800 F	1000 F		400 F	600 F	800 F	1000 F
short time	Good	Good	Good	Moderate			Good	Good	Good	Good		Good	Good	Good	Good
long time	Good	Good	Moderate	Poor			Good	Good	Good	Moderate		Good	Good	Good	Moderate
REMARKS ON FABRICATION															
Cutting	Satisfactory						Satisfactory–use sharp tooling and proper clearances					Satisfactory			
Machining	Suitable						Suitable–rigid set–up, positive feed, sharp tool					Suitable			
Forming	Simple parts at room temp; severe parts at elevated temp						Simple form at room temp; complex at elevated temp								
Joining, Welding	Fair						Fair					Not recommended			
REMARKS ON HEAT TREATMENT															
Initial Forging	1400–1750 F						1500–1800 F					1550–1850 F			
Annealing	1450 F, slow cool						1300 F, air cool					1450 F, air cool			
Solution Treating	1350–1500 F, water quench						1500–1725 F, water quench					1600–1700 F, water quench			
Aging	900–1000 F						900–1000 F, air cool					900–1100 F, air cool			
Stress Relief Annealing	1100 F						1100 F					1100 F			
NOTES AND GENERAL REMARKS	See Reference 1 for properties in aged condition. High strength, heat–treatable sheet, bar and forging grade. Supplied in annealed, solution–treated, and solution–treated and aged conditions. ① All mechanical property values nominal. ② Unnotched ③ < 0.070 inch thick ④ 0.070 to 0.187 inch inclusive						See Reference 2 for properties of 11/16 bar ① All mechanical property values are nominal ② Aged: 155–160,000 ③ Aged: 145,000 ④ Aged: 3–5 depending on size ⑤ Aged: 20 ⑥ < 0.070 inch thick ⑦ 0.070 to 0.187 inch, inclusive ⑧ Aged: 15T, < 0.070 inch						High strength bar and forging grade ① All mechanical property values nominal ② Aged: 150–170,000 ③ Aged: 140–160,000 ④ Aged: 8 ⑤ Aged: 20 ⑥ Aged: 500 hr: 100,000 ⑦ Aged: 500 hr: 42,000			

	Ti 45A — TABLE 34	Ti 55A — TABLE 35	Ti 65A — TABLE 36
	Titanium Metals Corporation of America	Titanium Metals Corporation of America	Titanium Metals Corporation of America
	Airframe, chemical, marine and similar applications, where highest formability required.	Airframe applications, skins, chemical industry applications where maximum formability required with reasonable strength	Airframe, chemical, marine and similar applications
	Sheet, strip, plate, bar, billet, wire, tubing, extrusions	Sheet, strip, plate, bar, billet, wire, tubing, extrusions	Sheet, strip, plate, bar, billet, wire, tubing, extrusions
	0.08% max C, 0.05% max N, 0.015% max H (sheet) ① 0.25% max Fe	0.08% max C. 0.05% max N, 0.0150% max H (sheet) ① 0.25% max Fe	0.08% max C, 0.05% max N, 0.015% max H (sheet) ① 0.25% max Fe
	Alpha	Alpha	Alpha
	Temperature	Temperature	Temperature
	Room: 45,000 ②③ / 35–55,000 ②④	Room: 55,000 ②③ / 45–65,000 ②④	Room: 65,000 / 55–75,000 ②③
	400 F ⑧: 32,000 / 24,000	400 F ⑨: 34,000 / 25,500	400 F ⑦: 42,500 / 26,000
	600 F ⑧: 25,000 / 19,000	600 F ⑨: 25,000 / 22,000	600 F ⑦: 30,000 / 14,000
	800 F ⑧: 24,000 / 19,000	800 F ⑨: 20,000 / 15,000	800 F ⑦: 26,000 / 12,000
	1000 F ⑧: 19,000 / 14,000	1000 F ⑨: 16,500 / 11,000	1000 F ⑦: 23,000 / 12,000
		–65 F: 78,000 / 48,000	–65 F: 100,000 / 74,000
	22 ②: 49 / 36 / 16 / 33	22 ②⑤: 42 / 37 ⑩ / 25 ⑩ / 31 ⑩	20 ②: 36 / 34 / 19 / 33
	35 ⑤	35 ⑥: 57 / 76 / 76 / 75	35 ④
	2T ⑥ 2.5T ⑦	2T ⑦ 2.5T ⑧	2T ⑤ 2.5T ⑥
	≅ 3–4T	≅ 3–4T	≅ 3–4T
	Brinell 190 ⑤	Brinell 200	Brinell 2.25 ④
			300 hr 60,000 / 100 hr 20,000
	14.9	14.9	14.9
	≅ 6.5	≅ 6.5	≅ 6.5
	0.163	0.163	0.163
	3038 ± 25 F	3000–3100 F	≅ 3000–3100 F
	57	56.7	57
	0.124 at room temperature	0.125 at room temperature	0.125 at room temperature
	9 at room temperature	11.5 at room temperature	11.5 at room temperature
	5.0	4.8	4.7
		5.3	5.3
		5.5	5.5
		5.6	5.6
		5.7	5.7
	400 F: Good / Good	400 F: Good / Good	400 F: Good / Good
	600 F: Good / Good	600 F: Good / Good	600 F: Good / Good
	800 F: Good / Good	800 F: Good / Good	800 F: Good / Good
	1000 F: Good / Good	1000 F: Good / Good	1000 F: Good / Good
	Readily cut on saw or abrasive wheel	Readily cut on saw or abrasive wheel	Similar to Ti 55A
	Rigid set–up, medium speed, deep feed, adequate coolant	Rigid set–up, medium speed, deep feed, adequate coolant	
	Maximum formability of commercially pure grades	Suitable	
	Completely weldable–fusion welding requires protection	Completely weldable	Completely weldable
	≅ 1650–1750 F rough breakdown, finish 1450–1550 F	≅ 1650–1750 F rough breakdown, finish 1550 F	≅ 1650–1750 F, finish at ≅ 1550 F
	1360 F, 1–2 hr, air cool	1300 F, 2 hr, air cool	1300 F, 2 hr, air cool
	1000–1100 F, 1/2 hr	1000–1100 F, 1/2 hr	1000–1100 F, 1/2 hr
	Lowest strength commercially pure grade. ① 0.0125% max H (bar); 0.0100% max H (billet) ② Sheet ③ Bar: 45,000 ④ Bar: 35,000 ⑤ Bar ⑥ < 0.070 inch ⑦ > 0.070 inch ⑧ 0.060 sheet	① 0.0125% max H (bar), 0.0100% max H (billet) ② Sheet ③ Bar: 55,000 ④ Bar: 45,000 ⑤ 20% in 1 inch ⑥ Bar ⑦ < 0.070 inch thick ⑧ > 0.070 inch thick ⑨ 5/8 inch rod ⑩ in 1 inch	Used where good formability and slightly higher strength than Ti 45A and Ti 55A are required. ① 0.0125% max H (bar), 0.0100% max H (billet) ② Sheet ③ Bar: 50,000 ④ Bar ⑤ < 0.070 inch thick ⑥ > 0.070 inch thick ⑦ 0.060 sheet

Titanium . . . . . .

DESIGNATION	Ti 75A — TABLE 37						Ti 100A — TABLE 38				
PRODUCER	Titanium Metals Corporation of America						Titanium Metals Corporation of America				
PRINCIPAL USES	Airframe, chemical, marine and similar applications						Aircraft engine parts, forgings				
AVAILABLE FORMS	Sheet, strip, plate, bar, billet, wire, tubing, extrusions						Bar, billet, wire, extrusions				
NOMINAL COMPOSITION	0.08% max C, 0.05% max N, 0.015% max H① (sheet), 0.25% max Fe						0.08% max C, 0.05% max N, 0.015% max H① , 0.12% max Fe②				
TYPE STRUCTURE	Alpha						Alpha				
MECHANICAL PROPERTIES	Temperature						Temperature				
	Room	400 F ⑧	600 F ⑧	800 F ⑧	1000 F ⑧	−65 F	Room				
Ultimate Tensile Strength, psi	80–110,000 ②③	42,000	31,000	29,000	21,000	123,000	80,000 ③				
Yield Strength, 0.2% offset, psi	70–95,000 ②④	32,000	23,000	21,000	15,000		70,000 ③				
Elongation in 2 inches, percent	15②	42⑨	38⑨	23⑨	28⑨		15③④				
Reduction of Area, percent	35⑤	65	79	80	76		30③				
Impact, Charpy V, ft-lb	11–15										
Fatigue Strength, ( ) cycles, psi	10^6 cycles 67,000										
Bend Radius	2T ⑥ 2.5T ⑦										
Welded Bend Radius	≅ 3–4 T										
Rockwell Hardness	Brinell 265 ⑤						Brinell 295③				
Rupture, Stress to produce in ( ) hr, psi	225 hr 65,000			430 hr 17,000							
Creep Data, Stress to produce ( ) percent elongation in ( ) hr, psi											
PHYSICAL PROPERTIES											
Modulus of Elasticity, psi, (10^6) tension	15.1						15.5				
Modulus of Elasticity, psi, (10^6) torsion	4.78						6.5				
Density, lb/cu inch	0.164						0.164				
Melting Range, deg F	3020 ± 18 F						≅ 3025 F				
Specific Electrical Resistivity micro ohms/cm/sq cm	60						58				
Specific Heat, Btu/lb/deg F	0.129						0.129				
Thermal Conductivity, Btu/hr/sq ft/degF/ft	9.84						≅ 9.84				
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 212 F	4.8						≅ 5				
32 – 600 F	5.3										
32 – 1000 F	5.5										
32 – 1200 F	5.6										
32 – 1500 F	5.7										
Oxidation Resistance in Air	400 F	600 F	800 F	1000 F			400 F	600 F	800 F	1000 F	
short time	Good	Good	Good	Good			Good	Good	Good	Good	
long time	Good	Good	Good	Good			Good	Good	Good	Good	
REMARKS ON FABRICATION											
Cutting	Readily cut with saw (max pressure) or abrasive wheel						Readily cut with saw or abrasive wheel				
Machining	Similar to 304 stainless steel, rigid set-ups recommended						Rigid set-up, sharp tools, slow speed, heavy feed				
Forming	Readily formable at room temperature						Readily formed (forged or rolled)				
Joining, Welding	Sound ductile welds (fusion, resistance) when protected						Completely weldable				
REMARKS ON HEAT TREATMENT											
Initial Forging	1750 F rough breakdown, finish 1550 F						1750 F rough breakdown, finish 1550 F				
Annealing	1300 F, 2 hr, air cool						1300 F, 2 hr, air cool				
Solution Treating											
Aging											
Stress Relief Annealing	1000 F, 1/2 hr, air cool						1000 F, 1/2 hr, air cool 1100 F				
NOTES AND GENERAL REMARKS	Highest strength commercially pure sheet grade. ① 0.0125% max H (bar), 0.0100% max H (billet) ② Sheet ③ Bar: 70,000 ④ Bar: 60,000 ⑤ Bar ⑥ < 0.070 inch thick ⑦ > 0.070 inch thick ⑧ 5/8 inch rod ⑨ In 1 inch						Highest strength commercially pure grade. ① 0.015% max H (sheet) 0.0125 max H (bar) 0.0100% max H (billet) ② 0.12% max Fe (sheet) 0.25% max Fe (bar) ③ Bar ④ In 1 inch				

Ti 5 A1 2.5 Sn	TABLE 39	Ti 13V 11 Cr 3 A1	TABLE 40	Ti 140 A	TABLE 41
Titanium Metals Corporation of America		Titanium Metals Corporation of America		Titanium Metals Corporation of America	
Designed for use primarily in sheet and strip form; for welded applications.		Advanced airframe applications, lightweight welded pressure vessels, airframe skins, suitable for honeycomb		Airframe applications	
Sheet, strip, plate, bar, billet, wire		Sheet, strip, plate, bar, billet, wire		Sheet, strip, plate, billet, bar, wire	
0.08% max C, 0.05% max N, 0.0175% max H (1) (sheet), 0.25% max Fe 4.5–6% A 1, 2–3% Sn		0.05% max C, 0.08% max N, 0.025% max H (sheet), 3.0% A 1, 11.0% Cr, 13.5% V		(1) 0.8% max C, 0.07% max N, 0.015% max H, 1.0–2.5% Fe, 1.0–2.5% Cr, 1.0–2.5% Mo	
Alpha		Beta		Alpha–Beta	
Temperature		Temperature		Temperature	
Room	400 F / 600 F / 800 F / 1000 F / –100 F	Room	400 F / 600 F / 800 F / 1000 F	Room (2)	400 F (7) / 600 F (7) / 800 F (7) / 1000 F (7)
115,000 (2) (3)	1000,000 / 88,000 / 80,000 / 78,000 / 160,000	125,000	122,000 / 115,000 / 123,000 / 101,000	130–145,000	96,600 / 85,200 / 69,700 / 46,600
110,000 (2) (4)	82,000 / 68,000 / 60,000 / 58,000 / 136,000	120,000	111,000 / 97,000 / 104,000 / 95,000	110–140,000	78,000 / 65,000 / 55,400 / 36,100
10 (5)	15 / 15 / 15 / 18	10 min	23 / 23 / 18 / 34	15	27.5 (8) / 24.5 (8) / 30 (8) / 66 (8)
25 (6)	42 / 42 / 42 / 43			25 (3)	72 / 73 / 88 / 100
19	18			14.5 (4)	
10^6 cycles 82,000					
4T (7) 4.5T (8)		3T (1) 3.5T (2)		3T (5) 3.5T (6)	
2.1T (9)		3T			
R_c 36				R_c 36 (3)	
1000 hr 108,000	1000 hr 66,000 / 1000 hr 62,000 / 1000 hr 20,000				
		0.2% 500 hr 148.000	0.2% 500 hr 131,000 / 0.2% 500 hr 107,000		0.4% 500 hr 60,000 (9) / 2.08% 500 hr 30,000 (10)
16		14 ; 13.2 at 600F; 11.6 at 1000F		16.3 at room temperature; 13.4 at 600 F	
				5.9 at room temperature	
0.162		0.175		0.168	
2822–3002 F				Liquidus: 3010 ± 25 F; Solidus: 2765 ± 20 F	
157				78 at room temperature; 119 at 600 F	
0.125 at room temperature, 0.152 at 800 F		0.12			
4.5 at room temperature, 7 at 800 F		4		6.8 at room temperature; 8.1 at 600 F	
5.2		Room temperature to 400 F: (5.4)		5.5	
5,3				5.4	
5.4				5.5	
5.5				5.5	
5.6					
400 F / 600 F / 800 F / 1000 F		400 F / 600 F / 800 F / 1000 F		400 F / 600 F / 800 F / 1000 F	
Good / Good / Good / Good		Good / Good / Good / Moderate		Good / Good / Good / Good	
Good / Good / Good / Good		Good / Good / Moderate–Good / Moderate		Good / Good / Good / Good	
Readily cut with saw or abrasive wheel. Abundant fluid recommended		Sawing–use maximum pressure; abrasive wheel–do not overheat		Readily cut with saw or abrasive wheel	
Rigid set–up, slow speed, heavy feed		Very slow speeds, moderate to heavy feed, adequate coolant		Rigid set–up, heavy feed, slow speed	
Formed at room temp whenever possible, slow–forming rates, may form to 1000F		Highly formable at room temperature in solution annealed condition		Highly formable in solution treated and annealed condition	
Fusion or resistance weldable, 100% joint efficiency if protected		Fusion welding, use protection, stress relieve 10 min, 1000 F		Marginal	
1850–1900 rough breakdown, 1650–1750 F finish		Rough breakdown 1950–2150 F, finish at 1400 F		1100–1200 F, 1 hr, air cool (sheet)	
1300–1500 F, 30–60 minutes, air cool		1400 F, 15 minutes, air cool		Sheet: 1425 F, 1/2hr, water quench; Bar 1450 F, 1/2hr, water quench	
		Synonymous with annealing in all–beta alloy (3)		Sheet: 1425 F, 1/2hr, water quench- Bar 1450 F, 1/2hr, water quench	
		900 F, 25 to 100 hr		900 F, 8 hr, air cool	
1000–1300, 30–60 minutes, air cool				1000 F, 1/2 hr	
Medium strength all-alpha alloy. (1) 0.0125% max H (bar), 0.0100% max H (billet) (2) Bar and sheet (minimum) (3) Bar and sheet (average): 120–130,000 (4) Bar and sheet (average): 120,000 (5) Sheet (Bar–10% elongation in 1 inch, minimum) (6) Bar (minimum) (7) < 0.070 inch thick (3T typical) (8) > 0.070 inch thick (3.5% typical) (9) For post weld stress relief, 1200 F; 30 minutes, 100 deg., 0.23 gage		See Reference 3 for properties in aged condition. (1) < 0.070 inch thick 2 > 0.070 inch thick (3) 15 minutes at 1400 F will complete a cold worked structure. Follow with air cool		See Reference 4 for properties in aged condition (1) Sheet: Bar: 0.8% max C, 0.05% max N, 0.0125% max H, 1.5–2.5% Fe, 1.5–2.5% Cr, 1.5–2.5% Mo (2) Sheet (3) Bar (4) at –100 F mill annealed 5/8 inch bar; 12 (5) < 0.070 inch (6) > 0.070 inch (7) 5/8 inch bar, mill annealed, 1200 F, 1 hr, air cool (8) in 1 inch (9) 550 F, total deformation (10) 750 F, total deformation	

Titanium • • • • •

DESIGNATION	Ti 4 Al 3 Mo 1 V — TABLE 42	Ti 155 A — TABLE 43
PRODUCER	Titanium Metals Corporation of America	Titanium Metals Corporation of America
PRINCIPAL USES	Airframe applications	Aircraft engine and airframe applications
AVAILABLE FORMS	Sheet, strip, plate	Plate, billet, bar, wire
NOMINAL COMPOSITION	0.08% max C, 0.05% max N, 0.015% max H, 0.25% max Fe, 3.5–4.5% Al, 2.5–3.5% Mo, 0.5–1.5% V	0.8% max C, 0.05% max N, 0.0125% max H (bar) ①, 5–6% Al, 1.1–1.7% Fe, 1.1–1.7% Cr, 0.9–1.5% Mo
TYPE STRUCTURE •	Alpha–Beta	Alpha–Beta

MECHANICAL PROPERTIES	Temperature					Temperature				
	Room	400 F ②	600 F ②	800 F ②	1000 F ②	Room	400 F ④	600 F ④	800 F ④	1000 F ④
Ultimate Tensile Strength, psi	131,000	98,000	90,000	82,000	65,000	155,000	134,000	125,000	112,000	74,000
Yield Strength, 0.2% offset, psi	122,000	90,000	85,000	78,000	60,000	140,000	122,000	110.000	99,400	61,400
Elongation in 2 inches, percent	11–12	20	18 ③	19 ③	35 ③	15 ②	15.5 ②	15 ②	18.5 ②	56 ②
Reduction of Area, percent						35	56.3	58	66	94
Impact, Charpy V, ft-lb						10.1 ③				
Fatigue Strength, ( ) cycles, psi						10^7 cycles 125,000			10^7 cycles 85,000 ⑦	
Bend Radius	2.6 T ①									
Welded Bend Radius										
Rockwell Hardness						R_c 39 max				
Rupture, Stress to produce in ( ) hr, psi										
Creep Data, Stress to produce ( ) percent elongation in ( ) hr, psi								0.2% 1000 hr 50,000 ⑤	1.4% 1000 hr 50,000 ⑥	

PHYSICAL PROPERTIES										
Modulus of Elasticity, psi, (10^6)	tension					16.5				
	torsion					6.3				
Density, lb/cu inch		0.163				0.163				
Melting Range, deg F										
Specific Electrical Resistivity micro ohms/cm/sq cm						163 at room temperature; 180 at 800 F				
Specific Heat, Btu/lb/deg F										
Thermal Conductivity, Btu/hr/sq ft/degF/ft						4.78 at room temperature; 6.97 at 800 F				
Mean Coefficient of Thermal Expansion per deg F, (10^{-6})	32 – 212 F	5				5.5				
	32 – 600 F					5.5				
	32 – 1000F					5.7				
	32 – 1200F					5.7				
	32 – 1500F					5.7				
Oxidation Resistance in Air		400 F	600 F	800 F	1000 F	400 F	600 F	800 F	1000 F	
	short time	Good	Good	Good	Good	Good	Good	Good	Good	
	long time	Good	Good	Good	Good	Good	Good	Good	Good	

REMARKS ON FABRICATION		
Cutting	Readily cut and sheared	Very satisfactory
Machining	Similar to Ti–6 Al–4 V	Rigid set–up, heavy feed, slow feed, adequate coolant
Forming	Excellent in solution treated condition	Forging 1650–1750 F
Joining, Welding	Not considered weldable; research continuing	Not classified as weldable

REMARKS ON HEAT TREATMENT		
Initial Forging	1750 F rough; 1650 finish	1650–1750 F
Annealing	1225 F, 4 hr, fast cool, 1300 F, 30 min, air cool	1200 F, 24 hr, air cool
Solution Treating	1640–1650, 10–15 min, water quench	1650 F, 6 hr, water quench
Aging	925 F, 6–12 hr, air cool	1000 F, 6 hr, air cool
Stress Relief Annealing	1000–1100 F, 1 hr, air cool	1000–1100 F, 1 hr, air cool
NOTES AND GENERAL REMARKS	See Reference 5 for properties in aged condition. High strength sheet alloy. ① Typical; < 0.070 inch; 3.5T; > 0.070 inch: 4T ② 0.063 sheet ③ Elongation in 1 inch	See Reference 6 for properties in aged condition. ① 0.0100% max H (billet) ② in 1 inch ③ At –100 F: 10 ④ 1/2 inch bar ⑤ 650 F, total deformation ⑥ 750 F, total deformation ⑦ 750F

	Ti 6 Al 4 V — TABLE 44	Ti 7 Al 4 Mo — TABLE 45	Ti 8 Al 1 Mo 1 V — TABLE 46
	Titanium Metals Corporation of America	Titanium Metals Corporation of America	Titanium Metals Corporation of America
	Airframe and aircraft engine parts (blades, discs, wheels, spacer rings), ordnance equipment	Aircraft engine and airframe applications	Airframe and aircraft engine applications requiring medium strength with high creep strength
	Sheet, strip, plate, bar, billet, wire, extrusions, tubing	Plate, bar, billet, wire, extrusions	Sheet, strip, plate, bar, billet
	0.08% max C, 0.05% max N, 0.0150% max H (sheet)① 0.25% max Fe, 5.5–7.5% Al, 3.5–4.5% V	0.08% max C, 0.05% max N, 0.0125% max H (bar) ① 0.25% max Fe, 6.5–7.3% Al, 3.4–4.5% Mo	0.08% max C, 0.05% max N, 0.0175% max H, 8.0% Al, 1.0% Mo, 1.0% V
	Alpha–Beta	Alpha–Beta	Alpha–Beta
	Temperature	Temperature	Temperature
	Room ② / 400F ② / 600F ② / 800F ② / 1000F ② / –65F	Room ② / 600F ⑥ / 800F ⑥ / 1000F ⑥ / –65F ⑥	Room / 400F ③ / 600F ③ / 800F ③ / 1000F ③
	142,000 / 114,500 / 107,000 / 101,000 / 82,400 / 155,000	145,000 ③ / 126,000 / 117,000 / 108,000 / 174,000	148,000 ① / 125,000 / 112,000 / 107,000 / 90,000
	133,000 / 100,500 / 91,500 / 83,900 / 65,400 / 141,000	135,000 ④ / 102,000 / 93,000 / 88,000 / 165,000	139,000 ① / 110,000 / 91,000 / 88,000 / 80,000
	15 / 17.5 ⑥ / 17 ⑥ / 18 ⑥ / 27 ⑥	10 ⑤ / 15 / 15 / 16 / 8 ⑤	16 ① / 15 / 20 / 16.5 / 20
	42.5 / 50.5 / 51.5 / 52.1 / 67.9	20 / 44 / 45 / 43 / 15	35–40 / 35 / 38 / 42 / 40 ④
	18 ③ / 16.5 ⑦	18.5 ⑥ / 14.5	20–28 ⑧
	10^7 cycles 110,000 / 10^7 cycles 70,000 ⑧	10^7 cycles 93,000 ⑦	(7)(10^6) cycles 82,500
	4.5 T ④ 5T ⑤		4.5 T average
	6–10 T		7–8 T average
	R_c 36	R_c 38	
	100 hr 98,000 / 100 hr 68,000	212 hr 50,000	200 hr 50,000
	0.2% 100 hr 52,000 ⑧ / 1% 1000 hr 21,000 ⑨ ⑩	0.26% 1000 hr 50,000 ⑧ / 2.19% 150 hr 30,000 ⑨	0.2% 150 hr 50,000 ⑤ ⑥ / 0.2% 150 hr 15,000 ⑦
	16.5 ②	16.7 at room temperature; 13.8 at 1000 F	19
	6.10 ②		
	0.161	0.162	0.156
	2920 ±20 F – 3020 ±25 F		
	171 at room temperature; 187 at 800 F	175	
	0.135 at room temperature	0.123	
	4.2 at room temperature; 6.8 at 800 F	3.7	
	5.3	5.0	4.7
	5.3	5.2	5.0
	5.3	5.6	5.6
	5.5	5.8	5.7
	5.7	6.2	
	400 F / 600 F / 800 F / 1000 F	400 F / 600 F / 800 F / 1000 F	400 F / 600 F / 800 F / 1000 F
	Good / Good / Good / Good	Good / Good / Good / Good	Good / Good / Good / Good
	Good / Good / Good / Good	Good / Good / Good / Good	Good / Good / Good / Good
	Readily cut with saw or abrasive wheel	Readily cut with saw or abrasive wheel	Readily cut with saw or abrasive wheel
	Rigid set–up with deep feeds and slow speeds	Rigid set–up with heavy feed, slow speed, sharp tool	Rigid set–up, heavy feed, slow speed
	Formable; hot forming useful with solution treated	Similar to Ti 6Al 4V using 50–100F higher temperature	Reforge temperature should exceed 1750–1800 F
	Sound ductile welds if protected		Marginal
	1900–2100 F, no higher than 1750 F to finish	Rough 1950 F; finish 1800 F	1950 F, finish from 1850 F
	1300 F, 2 hr, air cool	1450 F, 1 hr, or 1050 F, air cool	1650 F, 1 hr, (or 1800 F, 5 min), air cool + 1100 F, 8 hr, air cool
	1550 F, 1 hr, water quench or 1750 F, 1 hr, water quench	1700–1750 F, 1/2 – 1-1/2 hr, water quench	1825 F, 5 min – 1 hr, water quench
	900 F, 24 hr, air cool	1000 – 1150 F, 4–8 hr, air cool	1000 F, 8 hr, air cool
	1100F, 1/2 hr, or 1000F, 2 hr, air cool	1200–1300F, 1–2 hr, using highest practical temperature	1100–1200F, 1 hr, air cool
	See Reference 7 for properties in aged condition. ① 0.0125% max H (bar) ② 1-inch bar, unless noted ③ 5/8-inch bar ④ < 0.070 inch, 105F ⑤ > 0.070 inch, 105F ⑥ In 1-inch ⑦ –200F: 13; –321F: 10–15 ⑧ 750F ⑨ 850F ⑩ 0.2%, 100 hr: 24,000	See Reference 8 for properties in aged condition. ① 0.0100% max H (billet) ② Minimums ③ < 2 inches; > 2 inches: 140,000 ④ < 2 inches > 2 inches: 130,000 ⑤ In 8 inch ⑥ 1–1/64 inch rolled from 1850F ⑦ 3/4 inch ⑧ 850F ⑨ Total deformation; 2.25%, 150 hr: 40,000	See reference 9 for properties in aged condition. Material commonly duplex annealed at 1800 F, 5 min–1 hr, air cool + 1100 F, 8 hr, air cooled. ① Sheet, annealed: 1400 F, 8 hr, air cooled ② Annealed; 1400 F, 24 hr, air cooled ③ Duplex annealed, sheet or 1/4 inch bar ④ 1/4 inch bar only ⑤ Bar, 850 F, total deformation ⑥ 850 F, total deformation; 0.6%, 300 hr: 50,000 ⑦ Bar, total deformation; 950 F total deformation, 0.4%, 300 hr: 15,000 ⑧ At –40 F for duplex annealed 1-1/16 inch bar: 15–18

Titanium . . . . .

DESIGNATION	HA 1900 TABLE 47	HA 5A1 2.5 Sn TABLE 48
PRODUCER	Harvey Aluminum	Harvey Aluminum
PRINCIPAL USES	Nonstructured and moderately stressed aircraft parts; corrosion applications.	Applications requiring weldability and higher strength than available with commercially pure grade.
AVAILABLE FORMS	Billets, bars, forgings, extrusions	Billets, bars, rod, forgings, extrusions
NOMINAL COMPOSITION	0.0125% max H, 0.07% max N, 0.25% max O, 0.10% max C, 0.30% max Fe	4.0–6.0% Al, 2.0–3.0% Sn
TYPE STRUCTURE	Alpha	Alpha
MECHANICAL PROPERTIES	Temperature: Room ①	Temperature: Room ①
Ultimate Tensile Strength, psi	80,000	115,000
Yield Strength, 0.2% offset, psi	70,000	110,000
Elongation in 2 inches, percent	15	10
Reduction of Area, percent	30	25
Impact, Charpy V, ft-lb	10–11	
Fatigue Strength, ( ) cycles, psi	10^7 cycles 60,000	
Bend Radius		
Welded Bend Radius		
Rockwell Hardness		R_c 35
Rupture, Stress to produce in ( ) hr, psi		
Creep Data, Stress to produce ( ) percent elongation in ( ) hr, psi		
PHYSICAL PROPERTIES		
Modulus of Elasticity, psi, (10^6) tension	16.5	16.5
Modulus of Elasticity, psi, (10^6) torsion		
Density, lb/cu inch	0.163	0.161
Melting Range, deg F	3050	3000
Specific Electrical Resistivity micro ohms/cm/sq cm	54–58	
Specific Heat, Btu/lb/deg F	0.126	
Thermal Conductivity, Btu/hr/sq ft/degF/ft	10	
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 212 F	5.2	
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 600 F		
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 1000F		
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 1200F		
Mean Coefficient of Thermal Expansion per deg F, (10^{-6}) 32 – 1500F		
Oxidation Resistance in Air	400 F / 600 F / 800 F / 1000 F	400 F / 600 F / 800 F / 1000 F
Oxidation Resistance in Air, short time	Good / Good / Good / Moderate	Good / Good / Good / Moderate
Oxidation Resistance in Air, long time	Good / Good / Good / Moderate	Good / Good / Good / Moderate
REMARKS ON FABRICATION		
Cutting		
Machining		
Forming	High degree of formability	Less formable than commercially pure grade
Joining, Welding	Fusion weldable	
REMARKS ON HEAT TREATMENT		
Initial Forging	1800–2000 F	
Annealing	1500 F	1500 F
Solution Treating		
Aging		
Stress Relief Annealing	1300F	1350 F
NOTES AND GENERAL REMARKS	① Minimum values	① Minimum values

	HA 6148 TABLE 49	HA 6510 TABLE 50	MST 821 TABLE 51
	Harvey Aluminum	Harvey Aluminum	Reactive Metals, Inc.
	Moderate–strength forgings; airframe and jet engine compressor parts; special ordnance equipment.	Moderate- strength forgings; airframe and jet engine compressor parts; special ordnance equipment,	Applications requiring weldability, high temperature strength, good formability.
	Billets, bars, forgings, extrusions	Billets, bars, forgings, extrusions	Sheet, plate, bar, billet, wire
	5.5–6.5% Al, 3.5–4.5% V	6% Al, 4% V alloy held to close chemical control (1)	8.0% Al, 2.0% Cb, 1.0% Ta
	Alpha–Beta	Alpha–Beta	Alpha
	Temperature	Temperature	Temperature
	Room (1)	Room (2)	Room (1) / 400 F (1) / 600 F (1) / 800 F (1) / 1000 F (1)
	130,000	130,000	137,000 / 108,000 / 100,000 / 87,000 / 81,000
	120,000	120,000	130,000 / 93,000 / 81,000 / 74,000 / 62,000
	10	10	18 (2) / 20 (2) / 22 (2) / 28 (2) / 40 (2)
	25	20	45 / 50 / 53 / 57 / 70
			20
			10^8 cycles 80,000 (9)
	R_c 38	R_c 38	
			500 hr 87,000 / 500 hr 16,000
			1% 500 hr 64,000 / 1% 500 hr 17,000
	16.5	16.5	17.4
	0.160	0.160	0.1587
	3000	3000	
			193
			0.132 (4)
			3.72 (5)
			5.03
	400 F / 600 F / 800 F / 1000 F	400 F / 600 F / 800 F / 1000 F	
	Good / Good / Good / Moderate	Good / Good / Good / Moderate	
	Good / Good / Moderate / Moderate	Good / Good / Moderate / Moderate	
	Sound, ductile welds if good welding practice observed		Readily welded
	1700–1900 F	1700–1900 F	
	1300 F	1350 F	1650 F, air cool
	1715 F	1715 F	
	1000 F	1000 F	
	1200 F	1200 F	900–1400 F, 1–4 hr
	See Reference 10 for properties in aged condition. (1) Minimum values	See Reference 11 for properties in aged condition. (1) Aluminum content generally controlled on high side of range and vandium held to narrow limits. (2) Minimum values; actual values achieved through close chemical and process control are higher.	Offers low density, excellent creep resistance at elevated temperatures and good impact resistance. (1) Bar (2) In 1–inch (3) Unnotched (4) 200 F (5) 134 F

Titanium • • • • •

REFERENCE 1	RS 140	AGED			
REPRESENTATIVE MECHANICAL PROPERTIES	Temperature				
	Room	400F	600F	800F	1000F
Ultimate Tensile Strength, psi	180,000	162,000	152,000	140,000	100,000
Yield Strength 0.2% offset, psi	150,000	140,000	128,000	119,000	82,000
Elongation in 2 inches, %	4	6	7	9	20
Rockwell Hardness	R_c 38–42				

REFERENCE 2	RS 120 A 11/16 BAR ANNEALED			
REPRESENTATIVE MECHANICAL PROPERTIES	Temperature			
	400F	600F	800F	1000F
Ultimate Tensile Strength, psi	125,000	112,000	104,000	92,000
Yield Strength 0.2% offset, psi	115,000	105,000	96,000	72,000
Elongation in 2 inches, %	16	15	15	23
Reduction of Area, %	36	35	36.5	43

REFERENCE 3	Ti 13V 11Cr 3Al AGED				
REPRESENTATIVE MECHANICAL PROPERTIES	Temperature				
	Room	400F	600F	800F	1000F
Ultimate Tensile Strength, psi	190,000	182,000	177,000	155,000	114,000
Yield Strength 0.2% offset, psi	170,000	151,000	143,000	136,000	97,500
Elongation in 2 inches, %	4 minimum	8	10	10	12

REFERENCE 4	Ti 140 A	AGED			
REPRESENTATIVE MECHANICAL PROPERTIES	Temperature				
	Room	400F③	600F ③	800F③	1000F③
Ultimate Tensile Strength, psi	160,000–170,000①	136,000	120,000	103,000	52,000
Yield Strength 0.2% offset, psi	155,000①	100,000	87,000	65,000	30,000
Elongation in 1 inch, %	6–10 ①④	18.5	19	28	60
Reduction of Area, %		64	68	77	99
Impact Strength Charpy V, ft–lb	7.5 ②				
	Temperature				
	550F	750F			
Stress to Produce Rupture in ( ) hr, psi		462 hr 60,000			
Creep Data, Stress to produce ( ) percent elongation in ( ) hr, psi	0.11% 500 hr 60,000⑤	1.28% 500 hr 30,000 ⑤			

NOTES: ① Sheet, heat treated; 1425F, 1/2 hr, water quench + 900F, 8 hr, air cooled ② At –100F: 7 ③ 5/8 inch bar ④ in 2 inches ⑤ Total deformation

REFERENCE 5	Ti 4 Al 3Mo 1V AGED				
REPRESENTATIVE MECHANICAL PROPERTIES	Temperature				
	Room	400F	600F	800F	1000F
Ultimate Tensile Strength, psi	200,000	165,000	155,000	145,000	105,000
Yield Strength 0.2% offset, psi	170,000	140,000	130,000	120,000	80,000
Elongation in 1 inch, %	5–6 ①	5	5	5	20

NOTES: ① Elongation in 2 inches

REFERENCE 6	Ti 155A	AGED			
REPRESENTATIVE MECHANICAL PROPERTIES	Temperature				
	Room	400F	600F	800F	1000F
Ultimate Tensile Strength, psi	180,000	150,000	136,000	127,000	88,000
Yield Strength 0.2% offset, psi	173,000	135,000	119,000	105,000	73,000
Elongation in 2 inches, %	15 ①	15.5	15.5	18.5	47
Reduction of Area, %	25	55	58	69	97
Impact Strength Charpy V, ft–lb	8				
Fatigue Strength ( ) cycles, psi	10^6 cycles 111,000				
NOTES: ① in 1 inch					

REFERENCE 7	Ti 6A1 4V	AGED			
REPRESENTATIVE MECHANICAL PROPERTIES	Temperature				
	Room ①	400F ①	600F ①	800F ①	1000F ①
Ultimate Tensile Strength, psi	174,000	136,000	126,000	118,000	98,000
Yield Strength 0.2% offset, psi	162,000	112,000	99,000	92,000	77,000
Elongation in 2 inches, %	13	14.5 ④	13.5 ④	13.5 ④	21 ④
Reduction of Area, %	49	54	53	55	69
Impact Strength Charpy V, ft–lb	15.5 ②③				
Fatigue Strength ( ) cycles, psi	10^7 cycles 138,000		10^7 cycles 80,000 ⑤		
	Temperature				
	750F	850F			
Stress to Produce Rupture in ( ) hr, psi	1000 hr 88,000	1000 hr 53,000			
Creep Data, Stress to produce ( ) percent elongation in ( ) hr, psi		1% 1000 hr 34,000			
NOTES: ① 1 inch bar ② 5/8 inch bar ③ At –100F: 14.5 ④ in 1 inch ⑤ 750F					

REFERENCE 8	Ti 7A1 4Mo	AGED			
REPRESENTATIVE MECHANICAL PROPERTIES	Temperature				
	Room ①	600F ⑤	800F ⑤	1000F ⑤	–65F ⑤
Ultimate Tensile Strength, psi	170,000②	156,000	146,000	128,000	210,000
Yield Strength 0.2% offset, psi	160,000③	121,000	114,000	96,000	187,000
Elongation in 2 inches, %	8 ④	11	14	18	8 ④
Reduction of Area, %	20	31	42	66	12
Impact Strength Charpy V, ft–lb	10 ⑤				10
Stress to Produce Rupture in ( ) hr, psi				325 hr 50,000	
Creep Data, Stress to produce ( ) percent elongation in ( ) hr, psi			0.18% 150 hr 50,000 ⑥	0.72% 150 hr 30,000 ⑦	
NOTES: ① Minimums ② 1 inch; 1–2 inches: 160,000; 2–4 inches: 150,000 ③ 1 inch: 1–2 inches: 150,000; 2–4 inches: 140,000 ④ in 1 inch ⑤ 1-1/64 inch rolled from 1850F ⑥ 850F, total deformation ⑦ Total deformation; 1.94%, 150 hr: 40,000					

REFERENCE 9	Ti 8A1 1Mo 1V	AGED			
REPRESENTATIVE MECHANICAL PROPERTIES	Temperature				
	Room ①	400F ①	600F ①	800F ①	1000F ①
Ultimate Tensile Strength, psi	173,000	144,300	133,300	124,400	109,100
Yield Strength 0.2% offset, psi	153,000	118,700	106,400	98,100	85,300
Elongation in 2 inches, %	5	7.3	6.5	5	9.3
NOTES: ① Sheet, heat treated; 1825F, 5 min, water quench + 1000F, 8 hr, air cooled					

REFERENCE 10 HA6148	AGED
REPRESENTATIVE MECHANICAL PROPERTIES	Temperature
	Room
Ultimate Tensile Strength, psi	160,000
Yield Strength 0.2% offset, psi	150,000
Elongation in 2 inches, %	6
Impact Strength Charpy V, ft–lb	12
NOTES:	

REFERENCE 11 HA6510	AGED
REPRESENTATIVE MECHANICAL PROPERTIES	Temperature
	Room
Ultimate Tensile Strength, psi	160,000
Yield Strength 0.2% offset, psi	150,000
Elongation in 2 inches, %	6
Impact Strength Charpy V, ft–lb	12
NOTES: See notes on table 50	

Titanium

Design News

BASIC TITANIUM CAPSULE structure consists of welded, two-layered cones which are spot-welded to the titanium frame. The housing and adapter sections are not pressurized and consequently the skins are riveted to the frame in these areas.

For Free Reprints of this Design Data Article, Circle 527 on Reader-Service Card

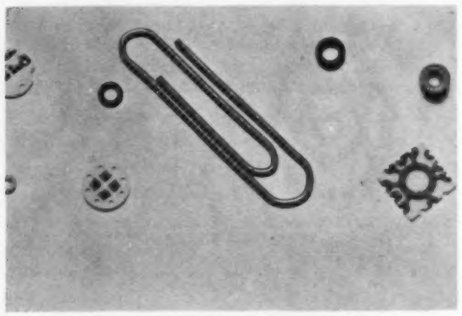
General-Purpose Resin 319

"Zytel 53" nylon-to-wire and cable resin combines both good stability and improved weather ability. It is transparent, making it useful in a number of molding applications. It is suggested in applications where transparency and resistance to occasional sunlight are requirements, such as in jacketing over color-coded primary installation. For continuous exposure to sunlight, black "Zytel 37X", containing 2-percent carbon black, is recommended. Some typical uses for "53" are hookup wire, control cable, gasoline-station wire, electric-blanket wire, building wire, radiant-heating wire and automotive-ignition wire. Other members of the family of resins offered to the wire and cable industry are: "Zytel 33", used in aircraft hookup wire jacketing; and "Zytel 69" mechanical cable covering.

E. I. du Pont de Nemours & Co., Wilmington, Del.

Metallized Ceramic-Base Transistor 320

Subminiature base mount of this transistor consists of a high-alumina ceramic wafer or washer 0.010 inch thick, which has been metallized using a molymanganese process. Conductive patterns are then nickel- or gold-plated to allow lead attachment as well as direct mounting of the silicon dice to the ceramic. The process permits mounting the silicon crystal on a high-strength dielectric with good vibration resistance and mechanical strength. Alumina base mount offers high-temperature properties (to 1700F). The thin ceramic wafer permits subminiaturization with no sacrifice of leakage path. The base mount is impervious to corrosive acids used in device processing and has zero porosity. Ceramic base matches closely the thermal expansion rate of silicon semiconductor crystal and can be mounted directly.



Advanced Vacuum Products, Inc., 430 Fairfield Ave., Stamford, Conn.

TEMPERATURE EXTREMES CREATE A DESIGN PROBLEM?

Du Pont coated fabrics made with silicones may help you solve it

INDUSTRIAL COATED FABRICS

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

Du Pont Fairprene® fabrics coated with silicones (polysiloxane polymers) offer a wide range of application possibilities in product design and improvement. Note these outstanding properties:

- They remain flexible even in sub-zero temperatures down to –65°F. . . . yet resist temperatures as high as 450°F.
- They resist oxidation, ozone, and corona . . . properties that add to their value in the electrical insulating field.
- Exceptional anti-stick qualities.
- Excellent electrical resistance and a dielectric strength of 500 VPM or better.
- Silicone rubber sheets are also ideal for gasketing materials in high- and low-temperature applications.
- They're strong and flexible.
- Resist oil and abrasion.
- Du Pont "Fairprene"-coated fabrics offer almost unlimited properties to help solve design problems. Fabrics of "Dacron"*, "Teflon"**, glass and other substrates are available with elastomeric coatings 38" wide and in thicknesses ranging from 1/64" to 1/8".

If you have a design problem, send coupon below for technical literature and samples of these fabrics. Du Pont has had wide experience in the development of coated fabrics for many applications, and stands ready to work with manufacturers in formulating coated fabrics or sheet stocks to meet specific requirements.

*"Dacron" is Du Pont's registered trademark for its polyester fiber.
**"Teflon" is Du Pont's registered trademark for its tetrafluoroethylene.

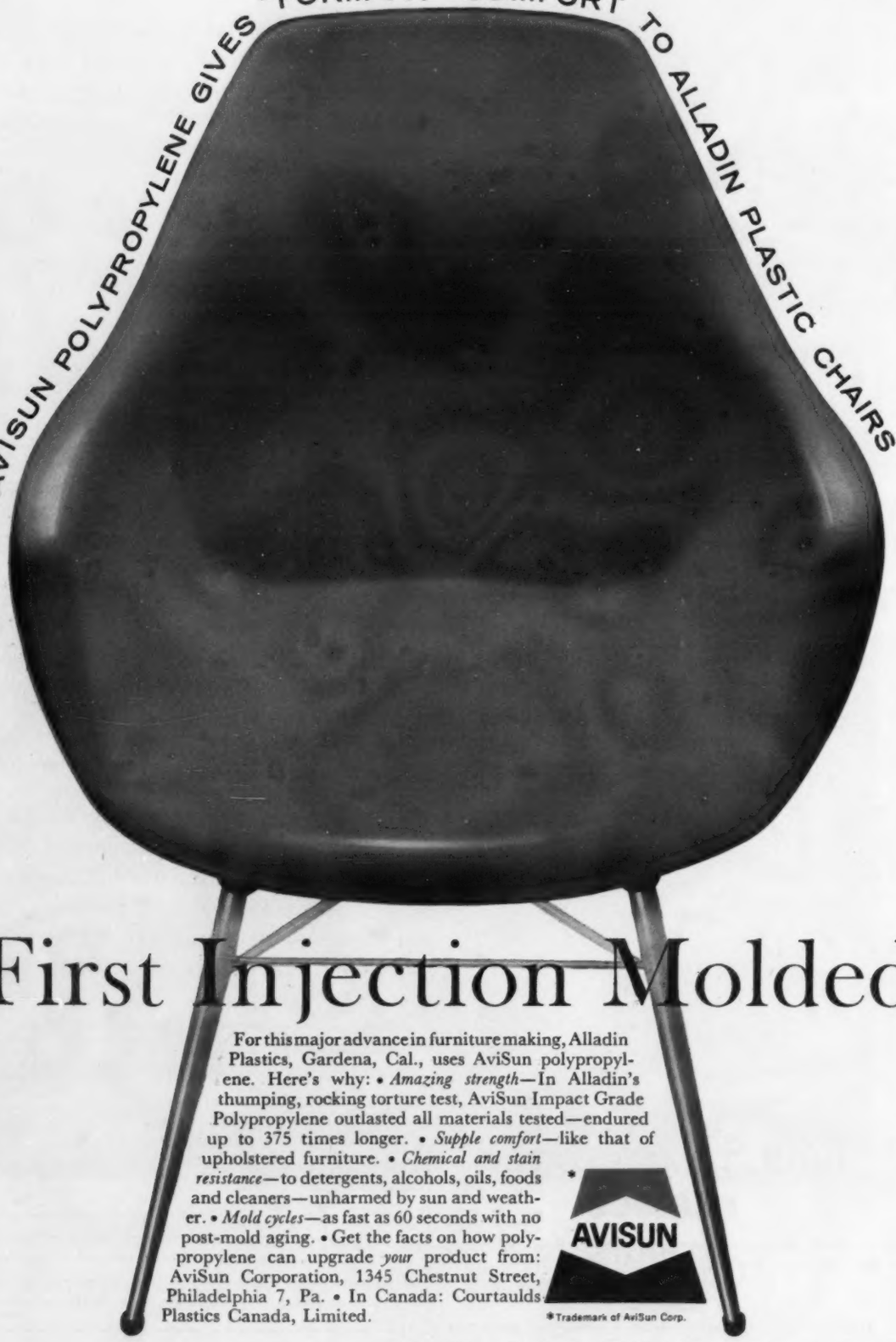
E. I. du Pont de Nemours & Co. (Inc.)
Fabric Trade Products, Dept. DN 1-10
Wilmington 98, Delaware

Please send literature on "Fairprene" fabrics coated with silicones.

Name_____
Position_____
Company_____
Address_____
City_____ Zone_____ State_____

Circle 61 on Reader-Service Card for more information

AVISUN POLYPROPYLENE GIVES "FORM-FIT" COMFORT TO ALLADIN PLASTIC CHAIRS



First Injection Molded Chair

For this major advance in furniture making, Alladin Plastics, Gardena, Cal., uses AviSun polypropylene. Here's why: • *Amazing strength*—In Alladin's thumping, rocking torture test, AviSun Impact Grade Polypropylene outlasted all materials tested—endured up to 375 times longer. • *Supple comfort*—like that of upholstered furniture. • *Chemical and stain resistance*—to detergents, alcohols, oils, foods and cleaners—unharmed by sun and weather. • *Mold cycles*—as fast as 60 seconds with no post-mold aging. • Get the facts on how polypropylene can upgrade *your* product from: AviSun Corporation, 1345 Chestnut Street, Philadelphia 7, Pa. • In Canada: Courtaulds Plastics Canada, Limited.

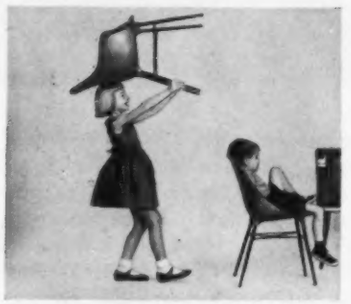
AVISUN*

*Trademark of AviSun Corp.

Why AVISUN polypropylene was chosen

Toughness and resiliency of polypropylene give the Alladin chair the ability to shrug off all kinds of rough handling.

Polypropylene's tensile strength, inherent in the material and easily designed into the chair, was highest by actual test over all competitive materials.



Because polypropylene is lightest of the plastics, the chair can be carried about with ease by any member of the family.

Circle 143 on Reader-Service Card for more information

Copper-Clad Laminate 321

A punching-grade copper-clad laminate offers good flame retardancy and low water absorption. Identified as CuClad N-6009, the material combines the high electrical properties of regular XXXP copper-clad laminates with good punching and machining qualities. It is designed for use in 105C (Class A) applications. The laminate meets the requirements for NEMA grade XXXP laminates as well as military specification MIL-P-13949B, Type PP. Specimens subjected to standard flame retardancy test (ASTM D 635-56T) extinguish themselves 3 sec after removal of the flame, according to the firm. Available with 1- or 2-oz copper foil bonded to one or both sides, it is useful for printed circuits requiring good electrical properties and punching characteristics. The laminate may be dip or float soldered without damage. Bond which joins electrolytically deposited copper foil to laminate has high peel strength and is not affected by standard plating and etching solutions. The material is available in 36- by 42-inch sheets with a satin finish and ranges in thickness from 1/32 to 1/8 inch. The laminate is also available as a flame-retardant, punching-grade stock without copper surfacing.

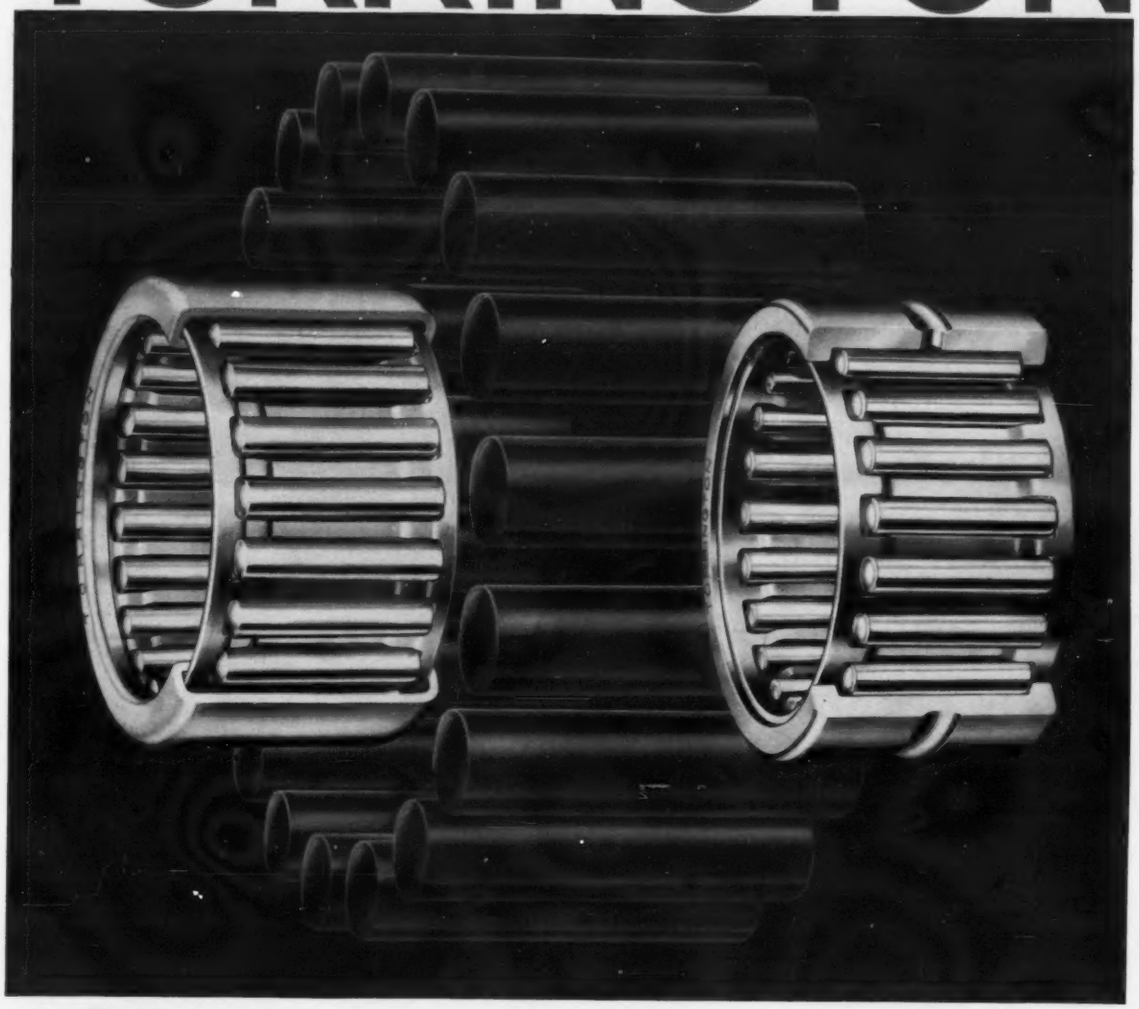
Minnesota Mining & Mfg. Co., Mica Insulator Div., Schenectady 1, N. Y.

'Teflon' Tubing 322

A seamless flexible conduit made of "Teflon" provides an easy solution to a wide variety of low-pressure flexible-connection and transfer problems in both plants and laboratories. Among its advantages is freedom from deterioration, corrosion and contamination both inside and outside the tube at temperatures from −100 to 500F. "Fluoroflex-T" is a good connection to weigh tanks, centrifuges and suction side of pumps for loading, unloading and decanting vessels and drums. It is useful for high-temperature, corrosionproof vent lines, low-pressure pipe connections, fumeducts and electrical conduits. Tubing currently is being produced in sizes from 1/2 to 3 inches with planned expansion through 6-inch dia, and in lengths up to 10 ft. Straight tubular ends, suitable for clamping or lap joint (Vanstone) ends, and lightweight flanges are standard.

Resistoflex Corp., Roseland, N. J.

TORRINGTON



WHATEVER THE DUTY...TORRINGTON HAS A BEARING FOR IT

Take these two bearings:

The unique Torrington Drawn Cup Roller Bearing opens new design possibilities in alternators, power-tool motors, electric mixers, vacuum cleaners and a host of similar products. It is so light, compact and efficient that designers have more flexibility than ever before. Yet the Drawn Cup Roller Bearing costs less than any other anti-friction bearing of comparable performance. In many cases, armature bearing costs have been reduced as much as 50%.

The Torrington Heavy Duty Roller Bearing is ready when the going is tougher. Controlled Contour rollers insure uniform loading and prevent stress concentration at the roller ends. A patented flange-riding retainer insures positive roller guidance and provides ample lubricant storage area. Torrington Heavy Duty Roller Bearings have proved highly successful in two-cycle engines, hydraulic pumps, oil-field equipment and transmission systems.

These are just two examples of Torrington's outstanding capability in bearing design and manufacture. Remember that Torrington makes **every** basic type of anti-friction bearing... can supply the bearing that's **exactly** right for your application. Don't hesitate to call us for advice.

progress through precision **TORRINGTON BEARINGS**

THE TORRINGTON COMPANY Torrington, Connecticut • South Bend 21, Indiana

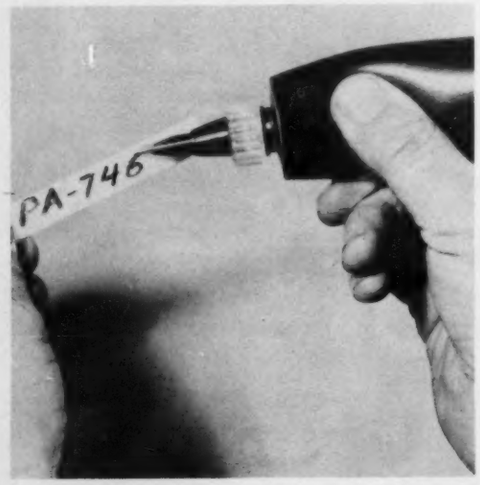
Circle 62 on Reader-Service Card for more information

Polyurethane Foam 323

A pot life of 20 minutes is featured in a line of polyurethane foams in the density range from 2 lb-ft³ to 20 lb-ft³. The amount of heat liberated in the delayed foaming reaction is reduced considerably. Other specifications are: dielectric constant, 1.25; dissipation factors, <0.003; volume resistivities, 10^{13}, K value, 0.25-0.30 BTU/sq ft/hr/deg F/in.

Rad Electronic Plastics, Inc., 1466 Herkimer St., Brooklyn 33, N. Y.

Permanent Marking System 324

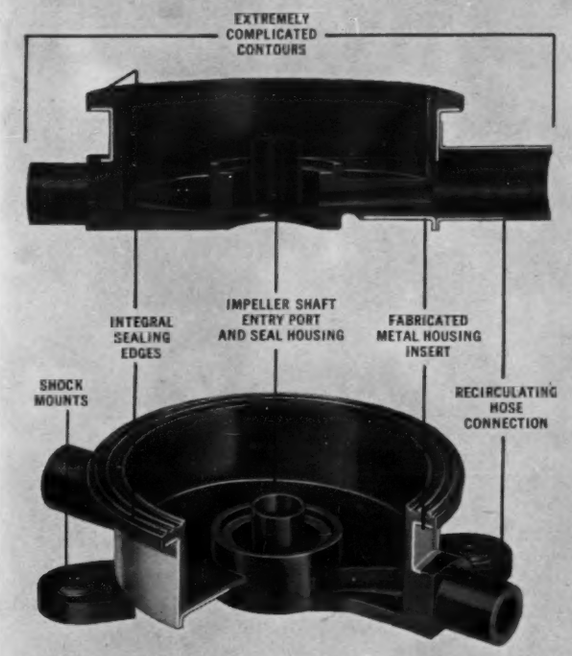


A new method has been developed for marking part numbers and other information on "Teflon". Key to the process is PA-746 "Teflon" treating agent, a high-potency compound that reacts with the "Teflon" surface to create a dark carbon film that is completely impervious to temperatures normally encountered in "Teflon" service. The treating agent is supplied in a polyethylene squeeze bottle with a long, tapered nozzle. Viscosity of the material is designed so that no fluid will leak out of nozzle unless pressure is applied, permitting the bottle to be used as a writing "crayon". Waxy surface of molded and extruded "Teflon" has made it difficult to mark such parts except with a wax-type pencil that can be rubbed off easily or which deteriorates with elevated temperatures. Limitation has applied not only to identifying marks but also to positioning guides, hole locations and similar marking requirements.

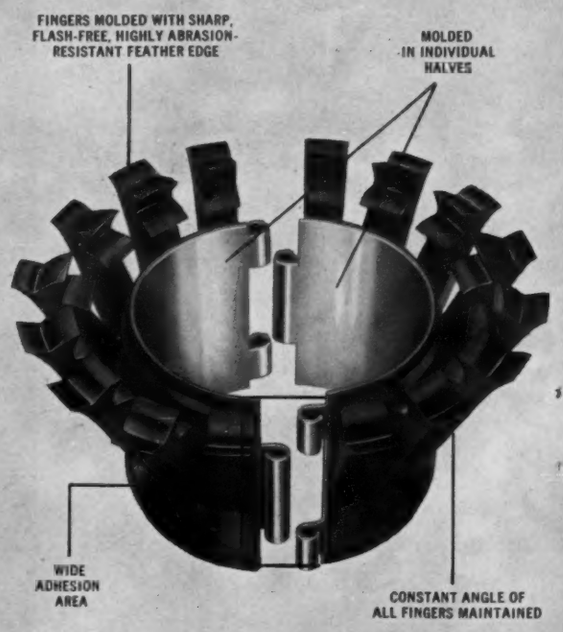
Plastic Associates, 2900 S. Coast Blvd., Laguna Beach, Calif.

OHIO RUBBER

"CUSTOMEERED COMPONENTS BASIC TO INDUSTRY"



DISHWASHER PUMP IMPELLER HOUSING—part for major household appliance manufacturer. **Problem Solved:** Intricate precise, compression molding and uniform rubber adhesion to fabricated metal insert. Constant, residual water, at varying temperatures, made absolute adhesion mandatory to prevent seepage and corrosion. Stock had to be non-absorptive, non-swelling, heat, ozone and detergent proof. ORCO designed, built, and maintains the molds—delivers consistent, high-quality rubber adhesion on a production line basis to rigid, quality-control standards.


FINGERS MOLDED WITH SHARP, FLASH-FREE, HIGHLY ABRASION-RESISTANT FEATHER EDGE
MOLDED IN INDIVIDUAL HALVES
WIDE ADHESION AREA
CONSTANT ANGLE OF ALL FINGERS MAINTAINED

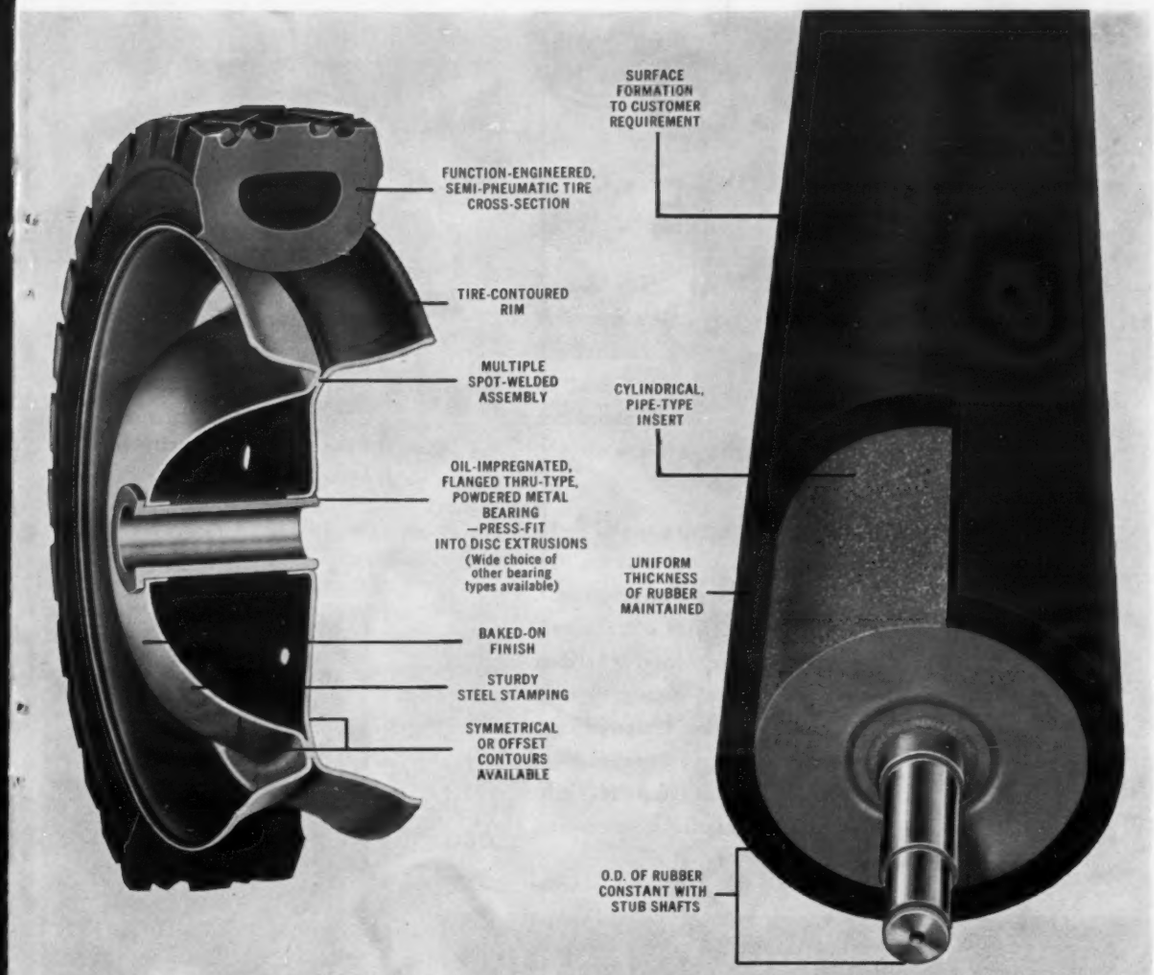
"RECIPO" OIL WELL WALL CLEANER—removes filter cake, mud, and foreign objects from bore hole. **Problem Solved:** Compression mold and bond-to-metal very flexible, high tensile, top quality natural rubber stock to extremely critical customer specifications. Design, build, operate, and maintain highly intricate molds to operate on normal production basis. Safeguard part against tremendous high stress concentration by engineering permanent, dependable, rubber-metal adhesion.

How ORCO "customeered" rubber parts

OHIO RUBBER IS THE GOOD SOURCE FOR THE O.E.M.!

As a "manufacturer's manufacturer", the OHIO RUBBER Company regularly serves, as above, many diversified industries and operates five, major, geographically-strategic plants to do so. From its facilities in depth, ORCO can—and does—deliver large quantities of natural rubber, synthetic rubber, silicone rubber, flexible and rigid vinyl, and polyurethane component parts—all "CUSTOMEERED" to your specifications.

To better serve the O.E.M., OHIO RUBBER designs, builds and maintains precision molds and dies . . . performs permanent bonding-to-metal . . . delivers injection, vacuum, compression, transfer, and automatic continuous moldings, as well as extrusions. And, all are backed by continuous statistical quality control, coordinated production control—and supervised by


SURFACE FORMATION TO CUSTOMER REQUIREMENT
FUNCTION-ENGINEERED, SEMI-PNEUMATIC TIRE CROSS-SECTION
TIRE-CONTOURED RIM
MULTIPLE SPOT-WELDED ASSEMBLY
CYLINDRICAL, PIPE-TYPE INSERT
OIL-IMPREGNATED, FLANGED THRU-TYPE, POWDERED METAL BEARING —PRESS-FIT INTO DISC EXTRUSIONS (Wide choice of other bearing types available)
UNIFORM THICKNESS OF RUBBER MAINTAINED
BAKED-ON FINISH
STURDY STEEL STAMPING
SYMMETRICAL OR OFFSET CONTOURS AVAILABLE
O.D. OF RUBBER CONSTANT WITH STUB SHAFTS

QUALITY SEMI-PNEUMATIC TIRES AND WHEELS—working components for movable equipment. **Problem Solved:** Provide a reliable source in depth for standard duty, industrial duty, and special duty wheels with accessories—all equipped with a wide range of job designed and proved tires and treads to meet customer applications. Wheels and tires are load and speed rated; field and laboratory tested. Full line available. Custom requirements can be met. Engineering and technical service offered.

HAY CONDITIONER ROLL—integral component for agricultural equipment manufacturers. **Problem Solved:** Maintain uniform adhesion of 6′ long, inch-thick, rubber blanket molded on cylindrical, customer-furnished insert. Surface configuration of roll to vary according to customer's specifications. Stock, field and lab tested, must be highly abrasion-resistant—yet resilient enough to cushion impact and passage of incidental debris without interfering with continuous conditioning function of roll.

aid product design

laboratory and engineering staffs second to none!

If you have a part that may work better as rubber, or with rubber, ORCO is eager to serve you. For complete details, at no obligation to you, write or phone us, today!

FREE! NEW RUBBER DESIGN DATA

These informative, factual manuals should be a part of your working library.

WRITE TODAY!

Factories: Long Beach, Calif. • Fort Smith, Ark. • Willoughby, O. • Conneautville, Penn. • Stratford, Conn.

ORCO **THE OHIO RUBBER COMPANY**

General Office • *WILLOUGHBY, OHIO* • WHitehall 2-0500

A DIVISION OF THE EAGLE-PICHER COMPANY

DB-61

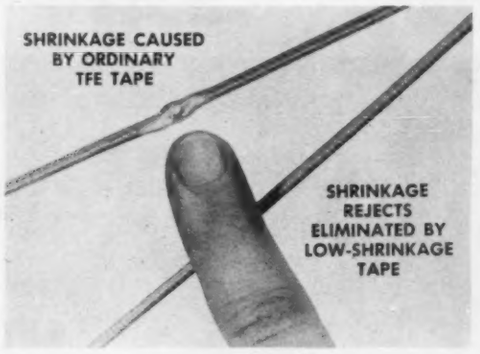
Circle 63 on Reader-Service Card for more information

Piezoelectric Ceramics 325

With the addition of three new ceramic bodies, C43B, C43C and C45, ceramics are now available in a complete line of unlimited shapes and sizes. Polycrystalline materials such as barium titanate and lead titanate zirconate can be fabricated by conventional ceramic techniques, such as dry pressing, slip casting and extrusion, to make almost any shape or size desired. Also obtainable are complete transducer assemblies for many applications such as underwater sound, various ordnance and missile devices, instrumentation and ultrasonic cleaning.

Sprague Electric Co., 177 Marshall St., North Adams, Mass.

Low-Shrinkage Tape 326



Specified on all small-diameter cable produced by the manufacturer, this improved "Teflon" tape is a regular skived material with controlled low shrinkage. A maximum of 2-percent change in any dimension will take place when the tape is heated at 730F for 15 minutes (the manufacturer states). This allows the material to be suited to insulating applications for prolonged exposure to high temperature. Tensile strength is 4000 psi minimum at 0.003 inch and elongation is 300 percent minimum. Dielectric strength offered is 2700 v/mil minimum. Tape is available in thicknesses from 1 mil up and in widths from 1/4 to 12 inches.

Dixon Corp., Bristol, R. I.

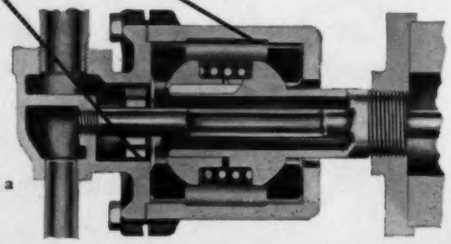
GRAPHITAR®

(CARBON-GRAPHITE)

FOR PERFORMANCE

Superior performance and unusually long service life, even in tough applications, is practically second nature to parts made of GRAPHITAR. That's because they combine GRAPHITAR's chemical stability, heat resistance, low coefficient of friction, adaptability to self-lubrication, mechanical strength, hardness and light weight. An everyday application of GRAPHITAR that illustrates well its versatility and remarkable performance can be found in the face-type valves employed in bulk station gasoline meters. These valves incorporate GRAPHITAR seats.

Here, GRAPHITAR's corrosion resistance, chemical inertness and resistance to expansion or contraction under rapid temperature changes, allow the valves to provide a leak-tight seal with excellent wear characteristics. These same characteristics are necessary for good performance wherever steam, gas and chemicals must be handled under the most adverse conditions. Perhaps your product can benefit from the top performance of GRAPHITAR, a unique and versatile engineering material.



Self-aligning seals of GRAPHITAR are employed in rotary pressure joints handling steam, water, hot oil, trichlorethylene, powdered talc and a variety of chemicals.

R-302-1

Comparative testing of various grades of GRAPHITAR self-aligning seals is accomplished on this equipment, which duplicates actual operating conditions. GRAPHITAR rotary pressure joint seals such as these often operate at 400 psi, at 650°F. and at rotary speeds of 600 ft/min.

GRAPHITAR is a material uniquely designed by its nature for solving tough problems and improving processing, and it can be further custom-engineered to meet your exact specifications. For complete information on GRAPHITAR . . . send for Engineering Bulletin #20.

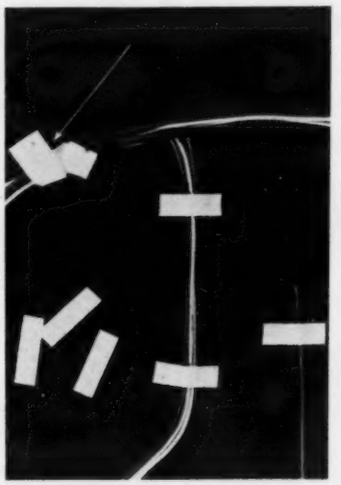
THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 2, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

Wiring Harness 327

A new two-part method of holding wire harnesses in place consists of loomed-memory nylon hooks and a loomed-memory nylon loop or pile. When the two are pressed lightly together, the hooks and loops engage, creating a substantial holding power. Separation is fast and simple – the two materials are pulled apart, the hooks temporarily straighten and release the loops before snapping back to their original hook shape. "Velcro" has no adhesive or sticky

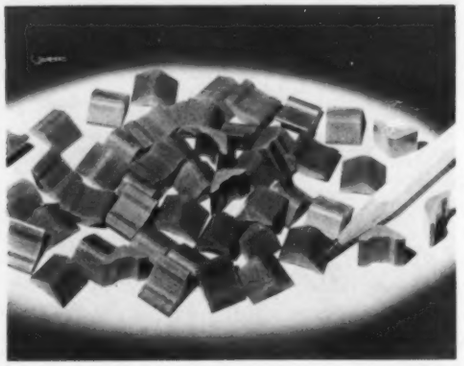


qualities and can be used for holding wiring harnesses in two ways. The harness can be mounted on a sheet of pile and small pieces of tape are pressed around the wires. The second way (see arrow) needs no large area of backing since tape is available back to back (the hooks on one side and the loops on the reverse side). Groups of wires are then held by simply wrapping the tape around in any desired direction.

Hartwell Corp., 9035 Venice Blvd., Los Angeles 34, Calif.

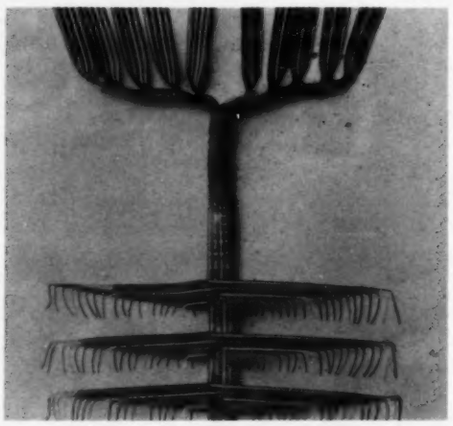
Circle 64 on Reader-Service Card

Cam Followers 329



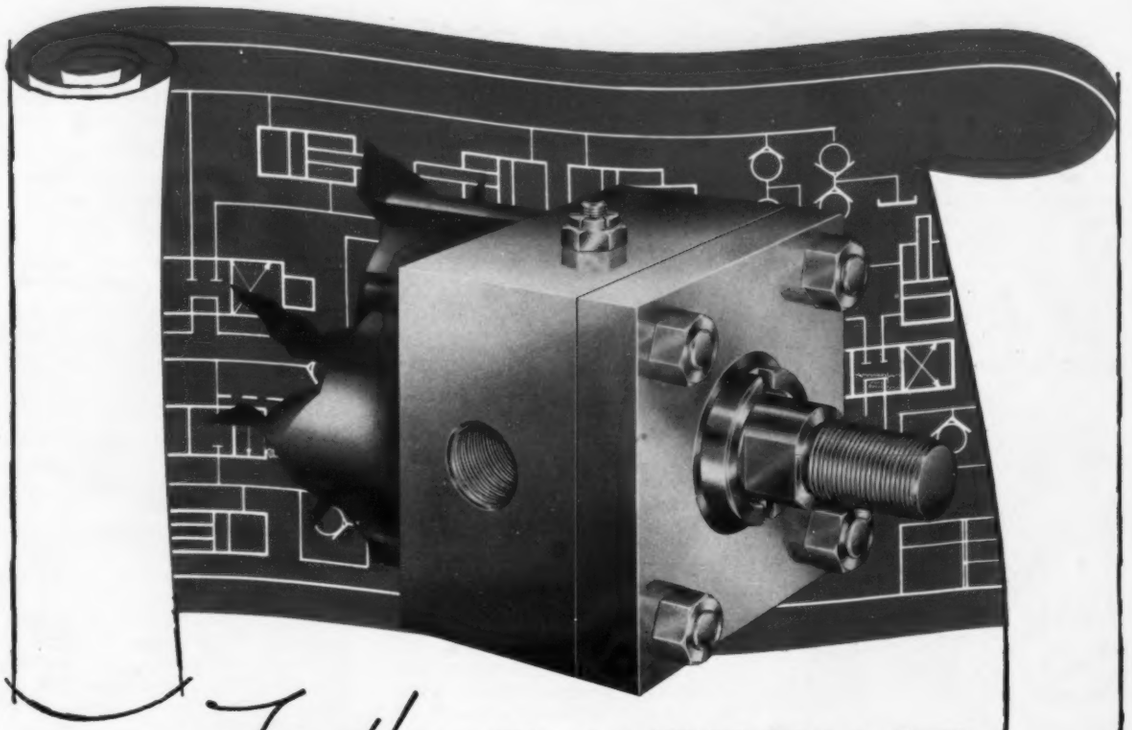
"Rulon" cam followers reduce cost of assembly and installation and decrease wear. The material is a fluorocarbon containing reinforcing agents which increase abrasion and surface resistance, offer a low coefficient of friction under non-lubricated conditions and provide high compressive strength. Thermal expansion is reduced by 50 percent (the manufacturer states). Other parts fabricated of "Rulon" include bearings, shaft seals, piston rings, O-rings, ball-bearing retainers and components requiring a chemically inert material.

Electronic Hookup Cables 330



Varicolored, multiconductor, flat bonded cables are composed of full-sized conductors No. 10 to 30 AWG. The cable is not a light-gage laminated material, yet space-saving features and flexibility are retained and color code is visible at all times. Special conductors such as coax, shielded wires and thermocouple leads can be built in. Flat strip construction aids in control of interconductor capacitance.

Spectra-Strip Wire & Cable Corp., Box 415, Garden Grove, Calif.

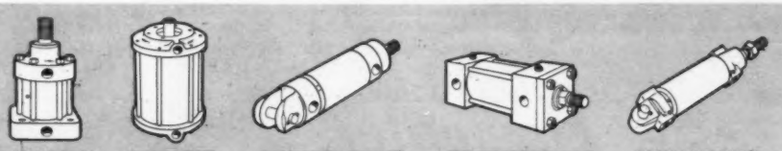


For the BLUEPRINT of your products...

SPECIFY **T-J** CYLINDERS . . . FOR YOUR POWER DRIVE DESIGN • APPLICATION OR REPLACEMENT MAINTENANCE

From its blueprint stage to its maintenance engineering requirement sheet, your product will assure MORE power drive precision and service, if T-J cylinders are specified. T-J's complete line too, from the Spacemaker to the new replaceable Squair Head, can be the answer to any power problem. Write or call The Tomkins-Johnson Company, 2425 W. Michigan Ave., Jackson, Michigan, today!

T-J OFFERS THE ONLY COMPLETE CYLINDER LINE



STANDARD HYDRAULIC | STANDARD PNEUMATIC | AIR and HYDRAULIC SPACEMAKER | AIR and HYDRAULIC SQUAIR HEAD | HIGH PRESSURE SPACEMAKER

PLUS complete catalog service

T-J TOMKINS-JOHNSON

RIVITORS...AIR AND HYDRAULIC CYLINDERS...CUTTERS...CLINCHORS

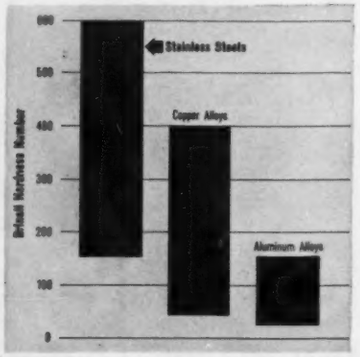
Representation in all major areas, including Canada.

Circle 65 on Reader-Service Card for more information

stainless steels give design engineers a wider application range

In your constant search for materials that serve a wide range of design applications, investigate the performance characteristics of Carpenter Stainless Steels. The following data highlight several important reasons why these versatile steels continually deliver bonus benefits to both design engineers and manufacturers.

Greater hardness range

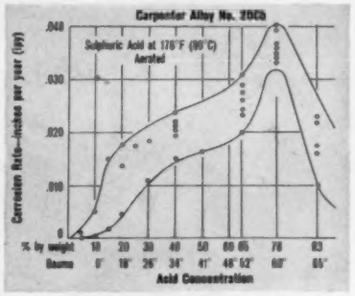


Only stainless steels can give you the combination of good corrosion resistance with sufficient range of hardness to meet any of your requirements. For example, fully annealed 18% Cr-8% Ni stainless steels such as Carpenter Stainless No. 4-A (Type 304) have a Brinell hardness of about 150, whereas heat treated Carpenter Stainless No. 440-C (Type 440C) can be as hard as 600 Brinell and both materials offer excellent resistance to a wide variety of corrodents. The range of hardnesses available with either copper-base or aluminum-base alloys is much smaller.

Superior machinability

The selection of Carpenter Stainless No. 5 (Type 416) for this level wind shaft for a fishing reel gave the manufacturer good machinability and eliminated expensive handwork on the shaft. It also provided excellent resistance to corrosion and unbeatable wearing qualities. A good example of a wise choice in metal selection.

Better corrosion resistance



The wide range of stainless steels available offers the designer the exact degree of corrosion resistance necessary for almost any corrosive environment. For mild corrodents, inexpensive Carpenter No. 1 (Type 410) can be used; for extremely severe corrodents such as hot sulphuric acid solutions, Carpenter No. 20Cb should be specified. For other corrodents, one of the many other stainless steels will be the most economical material for you to use.

Carpenter No. 20Cb is a special alloy first produced by Carpenter in wrought form. Its excellent resistance to hot sulphuric acid is shown in the chart above. For information on its resistance to other corrodents, send for booklet, "Super Corrosion Control."

Easier quality control

Here's an application where Carpenter Stainless No. 8 (Type 303) provided an unexpected bonus! These bushing and shaft assemblies for a push-button unit in an explosion-proof switch were formerly made from a non-ferrous metal. After switching to Carpenter Stainless No. 8 (Type 303) to gain more uniform machinability and non-corrosive properties, this customer eliminated a costly inspection operation on the finished shafts. This was due to the consistently true size of the No. 8 bars (total tolerance: .0005" as supplied by the Carpenter mill).

Carpenter Stainless is available to the designer in many forms. Billets, bars and wire in a wide range of sizes . . . strip, tubing or pipe of varying thicknesses. Whatever form best suits your needs, you'll find one unique feature of Carpenter Stainless . . . its *consistent uniformity*. There's never the slightest change in composition in any one grade of Carpenter Stainless, no matter how big the order. Day after day, year after year, each melt of Carpenter Stainless is carefully controlled with the best equipment and human effort to bring you a reliable, consistent material, unsurpassed in uniformity. When the product you design goes into production, this consistent uniformity be comes extremely important. Specify Carpenter Stainless, and take a big step toward approval of your project.

Technical data available

Complete information on properties and characteristics of all grades of Carpenter Stainless is available in data sheet form. Send for yours today.

Carpenter steel

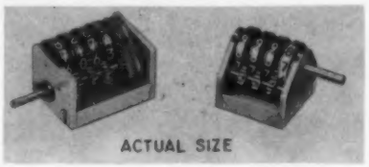
you can make it ***consistently*** better with Carpenter Stainless Steels for specialists

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Export Dept., Port Washington, N. Y.—"CARSTEELCO"
Alloy Tube Division, Union, N. J.
Webb Wire Division, North Brunswick, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.

Circle 66 on Reader-Service Card for more information

MECHANICAL

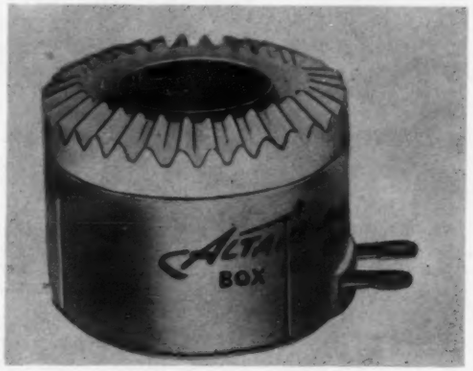
Subminiature Counters 331



Two reversible subminiature counters utilize drums measuring only 0.288 inch in dia, with digits of 0.075 inch high by 0.045 inch wide. Model 1005 features a 200: 1 gear reduction, providing 20 revolutions of input shaft with an output of 1 count on the unit's drum. Pitch of the gears in the train is 120. Package size is 7/16 inch wide by 5/8 inch long (not including shaft length) by 29/64 inch overall height. Input speed is 5000 rpm maximum. Package size of Model 1006 is 7/16 inch wide by 15/32 inch long (not including shaft length) by 29/64 inch overall height. Frames are anodized aluminum, shafts are stainless steel and bearings are oilite. Drums are anodized aluminum with engraved digits for military applications.

Haydon Instrument Co., 17 Brown St., Waterbury 20, Conn.

Nylon-Gear Magnetic Clutch 332



Fitted with steel housing and a nylon gear mounted on ball bearings, Model MC541 has been designed for incorporation in multiple clutch-potentiometer assemblies. If desired, a coupling is available which converts clutch to an in-line drive. The unit is only 1 inch in dia and 1 inch long. It has a minimum torque of 6 oz-in and exerts no drag on potentiometer when de-energized. Units are available with coil voltages of 6 to 110v d-c.

Altair Research & Mfg. Co., Box 106, Baldwin Park, Calif.

the Air Damping Dashpot for

- System Stabilization
- Vibration Damping
- Time Delay

AIRPOT

With its precision bore glass cylinder and graphitized carbon piston, the AIRPOT is equipped for a wide diversity of applications. Among its many uses are vibration damping in rate gyros, time delay in coin mechanisms, stabilization of instrument recording pens and damping of the REGOHM precision voltage regulator.

TYPICAL PERFORMANCE DATA INCLUDES:

ONE OR TWO WAY DAMPING: Push or pull or push-pull

SIMPLE SCREWDRIVER ADJUSTMENT

POSITIVE CALIBRATION through millions of cycles

WIDE TEMPERATURE RANGE: —75°C to +150°C

CHOICE OF CYLINDER LENGTHS to suit application

Find out how this unusual component can solve one of your engineering problems. Complete description and specifications on request.

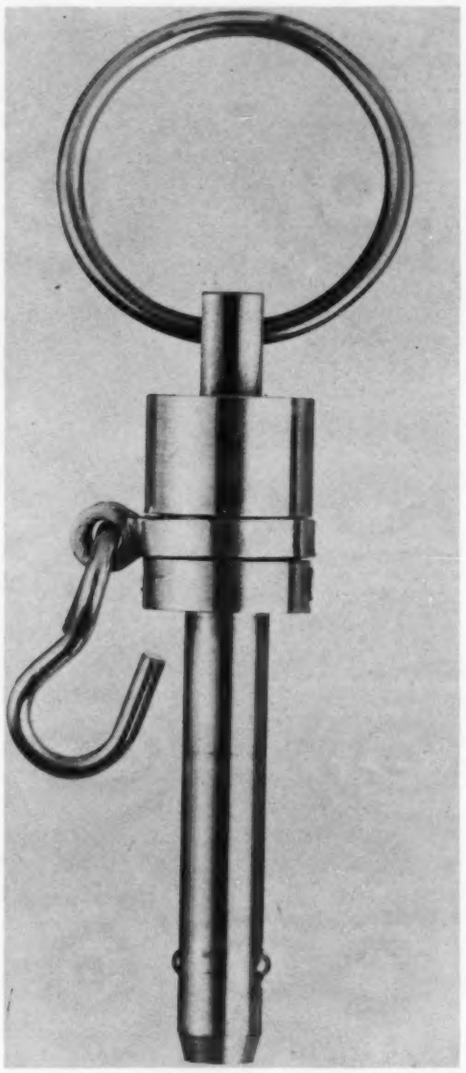
ELECTRIC REGULATOR CORP. NORWALK, CONNECTICUT

Circle 67 on Reader-Service Card

Quick-Release Pins 333

Single-acting, quick-release pins push to install — pull to remove. Pins are available in ring handle (as pictured), T-handle and L-handle types. Stainless-steel balls projecting beyond the OD of pins provide a positive lock against unintentional pin removal. When the actuating handle is pulled, balls retract and pin is pulled out. When the handle is pushed, balls again retract and pin is pushed into installed position. Release of any force on handle locks the balls in projecting position, preventing removal of pin. Standard pins are available in 17-4 PH and 4130 steel and in either two-ball or four-ball styles designed to NAS standards. Special pin handle configurations are available upon request.

Hartwell Corp., 9035 Venice Blvd., Los Angeles 34, Calif.



THE IDEAL PRODUCTION-LINE FASTENER

"POP" Rivets cut your fastening costs on the production line, because they're set from one side by one operator, using light-weight tools that are taken to the work. Rivets can be pre-positioned; setting is unusually fast and easy, with no danger of marring work surfaces, burring rivet heads, or stripping rivets from the work. Fastening quality and grip strength are uniformly high . . . and do not vary with the strength or skill of the operator. Setting tools are moderate in cost . . . and are available in manual, hydraulic and pneumatic types.

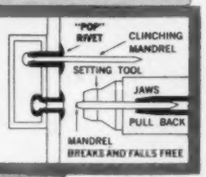
Remember, we've given you just one of the one dozen reasons why "POP" Rivets run rings around the rest. If you're interested in improving the quality, appearance and sales appeal of your products . . . and reducing fastening costs at the same time . . . be sure to investigate all the reasons that make "POP" Rivets the first choice for modern fastening.

Genuine "POP" Rivets are available through a large network of distributors throughout the country. Write today for complete information . . . and for the name of your local "POP" Rivet Distributor.

UNITED "POP" RIVETS

HERE'S HOW THEY WORK

"POP" Rivets are inserted and set from the same side: (1) Rivet is inserted in the work. (2) Jaws of the easy-to-use setting tool grasp the mandrel. (3) Tool is operated. Jaws pull back. Rivet is set. Mandrel breaks and falls free.



FASTENER DIVISION • UNITED SHOE MACHINERY CORPORATION
1925 River Road, Shelton, Connecticut, U.S.A.

Circle 68 on Reader-Service Card for more information

Magnetic Encoder 334

One of the smallest in the field, this noncontacting, Gray code, magnetic, shaft-angle encoder also is one of simple design. BuOrd size 18 and synchro mount, it provides accurate readout at 10,000 rpm and has low starting and running torques. The code is nonambiguous and the unit is mechanically interchangeable with existing brush-type encoders. Clockwise or counterclockwise rotation is offered. Output cir-

cuitry may be specified to match input requirement of customer logic circuits. The device is suitable where environmental conditions cannot be met by brush-type encoders, for servo and shaft position encoding (low-to-medium resolution) and for single-turn or high-resolution multiturn applications.

United Aircraft Corp., Norden Div., Commack, L.I., N.Y.

Circle 69 for Reader Service

Custom Quality

OHIO COLD DRAWN

features improved physicals, closer tolerances, better finish

Arrows indicate approximate center of weld line. After normalizing, cold drawing and annealing, the weld area cannot be detected even when the polished and acid-etched surface is magnified 100 diameters. This perfect microstructure makes Ohio Drawn-Welded, in every sense, weldless — an ideal tubing for critical mechanical and pressure applications. In addition to cold drawing, a severe test in itself, non-destructive tests such as air, water, magnetic and eddy current, insure 100% acceptability.

A-4363A

WELDED STEEL TUBING

Now Available in Larger Sizes... Heavier Wall Thicknesses

NEWS ITEM:

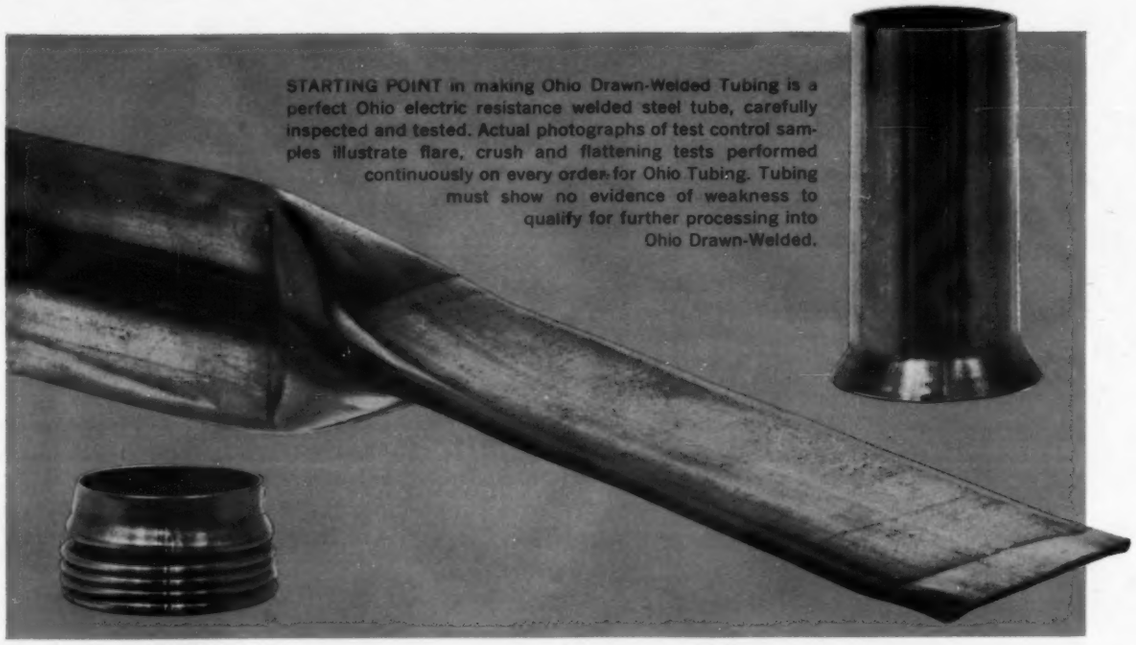
Ohio Seamless is now cold drawing quality electric resistance welded steel tubing up to 7¼ inches with wall thicknesses to .344. Ohio Custom Made Drawn-Welded Tubing is here now — in greater range of sizes, wall thicknesses, finishes than ever before.

TECHNICAL ITEM:

Controlled normalizing assures desired microstructure . . . Precision cold drawing imparts special physical properties, assures uniform wall thickness, delivers closer dimensional tolerances and superior surface finish.

ACTION ITEM:

This all adds up to a new major-source capability that can help you design with new freedom, manufacture at lower costs. Mark your orders: Ohio Custom Made Tubing. Either welded or seamless, it's your best buy whenever tubing is the best shape.



STARTING POINT in making Ohio Drawn-Welded Tubing is a perfect Ohio electric resistance welded steel tube, carefully inspected and tested. Actual photographs of test control samples illustrate flare, crush and flattening tests performed continuously on every order for Ohio Tubing. Tubing must show no evidence of weakness to qualify for further processing into Ohio Drawn-Welded.

OHIO

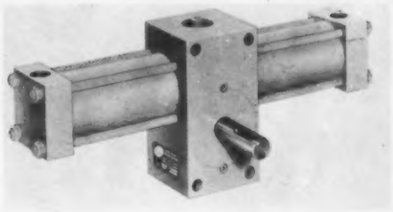
OHIO SEAMLESS TUBE

Division of Copperweld Steel Company • **SHELBY, OHIO**

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

Representatives in principal cities. Check leading directories:
THOMAS', MacRAE'S, CONOVER-MAST, SWEET'S, FRASER'S.

Constant-Torque Rotary Actuator 335



Three models of a reversible rotary actuator are being manufactured, driven by air or hydraulic fluid pressure. The units develop 50 to 314 in-lb of torque with 100-psi pressure. Two opposing pistons move a gear rack over a pinion on a drive shaft for any desired rotation to 360 deg. Shaft may be stopped and rotation reversed at any part of the cycle. Keyed for use with stock worm or spur gears or special cam or lever attachments, the actuator's functions include power steering, gate operation, indexing, tool positioning and azimuth control.

MO-BAR Hydraulics Co., Crystal Lake Ill.

Self-Locking Fasteners 316

One-piece, all-metal "Place Bolts" demonstrate a 21-percent increase in release torque in both tension and vibration tests. The free-spinning cap screws have an elastic diaphragm which furnishes additional elongation when bolt is tightened. The impact-formed units are fabricated of either carbon or alloy steel. Light in weight, the bolts find application in auto and truck chassis and axle parts, compressors, gasoline and diesel engines and ordnance vehicles.

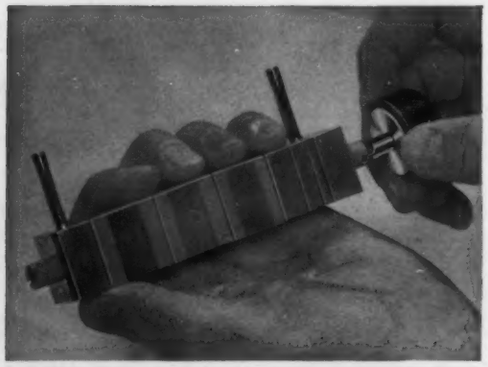
Screw & Bolt Corp. of America, 2 Gateway Center, Pittsburgh 22, Pa.

Circle 69 on Reader-Service Card

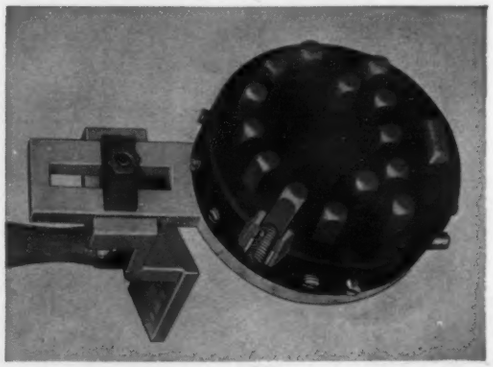
Practical Design Tips

No. 5 of a series

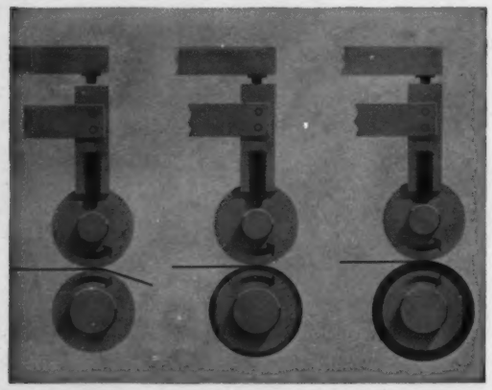
Cost conscious product designers are finding new uses for Vlier products in all types of original equipment. Simple applications such as shown below are saving hundreds of dollars. Examine your drawings and products today and see where these inexpensive, off-the-shelf parts can lower your costs.



TORQUE APPLIED TO ASSEMBLE PRECISION GAGE BLOCKS is limited by this modified Vlier Torque Thumb Screw. Ground screw point mates with assembly screw; prevents overtightening with resultant damage to blocks. Torque Screws are available in four types, many thread sizes, lengths and end pressures.



SPRING-LOADED BALL PLUNGERS HOLD MARKING STAMPS IN POSITION, yet allow them to move freely when struck. Ball Plungers are threaded into metal inserts molded in rubber. Binding action of rubber prevents plungers backing off. Plungers come in six models; sizes from #4-48x3/16. to #5/8-11x1; 18 end pressures.



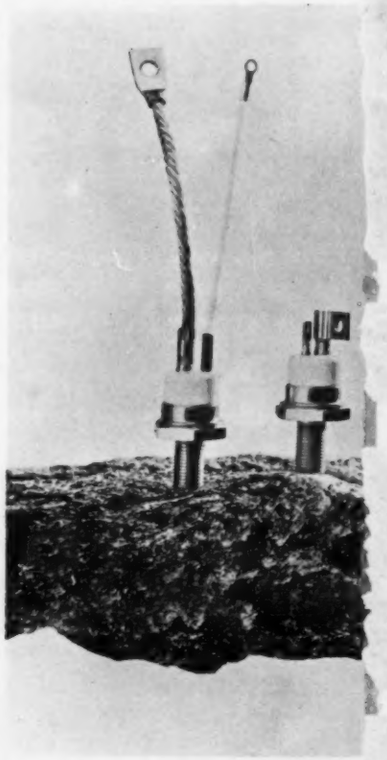
LIMIT SWITCHES ON THIS TEXTILE DRAWING FRAME ARE PROTECTED by Vlier Spring Plungers. Bunching of broken threads causes rolls to lift, actuating limit switches which automatically shut off the machine. Plungers permit normal operation of the switches, but limit over-travel of switch actuating arm. Spring Plungers are available in four models, 50 sizes, various end pressures.

FREE IDEA BOOKLET! This informative 16-page booklet shows how other original equipment manufacturers are profiting from the use of standard Vlier parts. It may suggest ways you can save, so write for your copy today.

VLIER
Engineering Corporation
A subsidiary of Barry Wright Corporation
8900 Santa Monica Blvd. • Los Angeles 46, California

Circle 70 on Reader-Service Card for more information

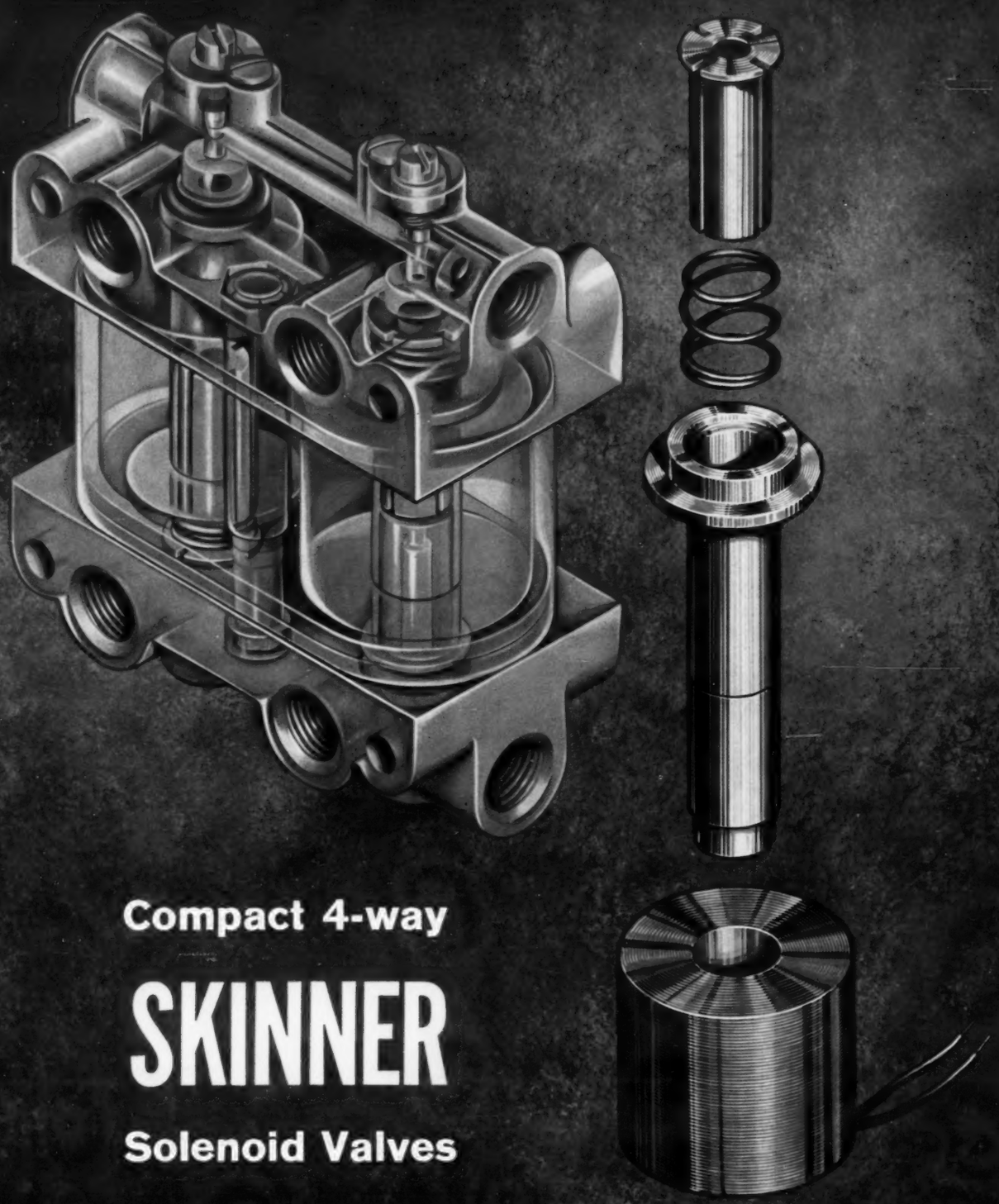
70-Amp Rectifiers 3



"Rock-Top" Trinistor-controlled rec fiers with a d-c rating of 110 amps a designed for high-power switching s vice in military and industrial applic tions. Voltage ratings through 400v available. Units are supplied with eith flexible leads or flag-type terminals d signed to facilitate mounting in comp assemblies. Glazed ceramic heade hard-soldered junctions and hermetical weld-sealed cases are used to insure d pendable operation under severe app cation conditions. Rectifiers are used replace magnetic amplifiers, thyratron rotating amplifiers and other control d vices. In applications such as speed co trols, inverters, regulators and stat contactors, these high-power semico ductors offer reduced maintenanc better performance, higher reliability an higher efficiency.

Westinghouse Semiconductor Dep Westinghouse Electric Corp., Youn wood, Pa.

Circle 71 on Reader-Service Car



Compact 4-way

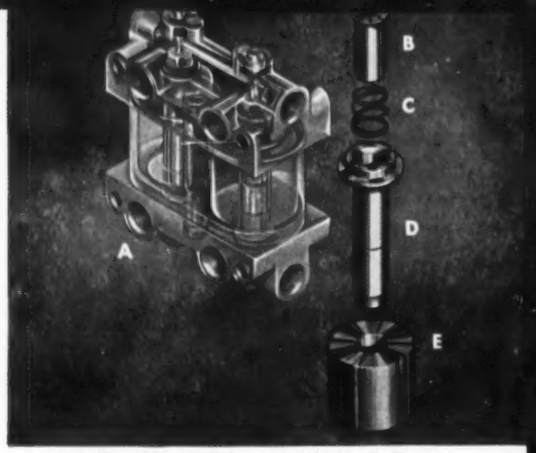
SKINNER

Solenoid Valves

assure precise cylinder control

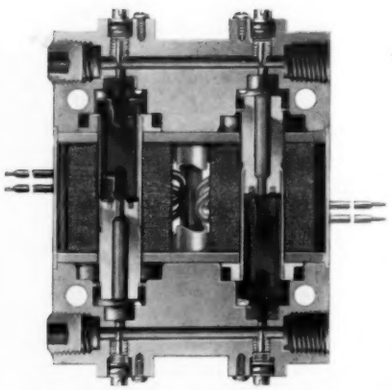
Here's how accurate, dependable operation is built into SKINNER 4-way solenoid valves

- **Precise flow control**—by adjustable metering
- **Compact, direct acting**—two 3-way valves in one housing
- **Durable and corrosion resistant**—stainless steel internal parts
- **Leakproof, bubbletight sealing**—soft, synthetic inserts
- **Positive operation mounted in any position**—spring-loaded plungers
- **Underwriters approved**—wide selection of coils, voltages and frequencies
- **Wired from front or rear**—housing easily reversed
- **Adaptable to many uses**—optional porting arrangements



A. Transparent view of 4-way solenoid valve B. Plunger C. Plunger return spring D. Sleeve E. Coil

SKINNER four-way solenoid valves available in three basic types



The Skinner V9 solenoid valve is two 3-way valves in one compact housing. Both valves may be independently controlled and metered to provide accurate, dependable control of single- or double-acting cylinders, or larger pilot-operated valves.

V9 types are available without adjustable flow and with metering at both exhaust ports, both inlet ports or full metering of all ports.

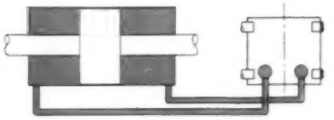
• • •

For complete information, contact a Skinner Distributor listed in the Yellow Pages or write us at the address below.

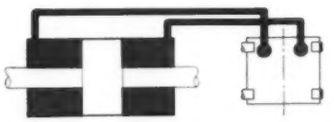
V9 SERIES SPECIFICATIONS

Media—air, hydraulic oils, inert gases
Orifice Diameter—$\frac{3}{64}$", $\frac{1}{16}$", $\frac{3}{32}$", $\frac{1}{8}$"
Pipe Size—$\frac{1}{4}$" NPTF
Maximum Operating Pressure Differential—0 to 150 PSI (up to 225 PSI also available)
Temperature Range—minus 40°F. to plus 180°F.
C_v Factor—$\frac{3}{64}$" .052, $\frac{1}{16}$" .095, $\frac{3}{32}$" .156, $\frac{1}{8}$" .214
Mounting—$\frac{1}{4}$" through-bolt holes.

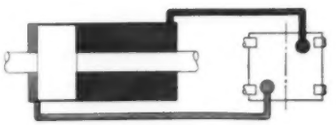
Normally closed—normally closed V933 valves with a neutral position. Generally applied on double-acting cylinders where the piston is in a neutral position without pressure when both coils are de-energized. This permits manual shifting of the piston without operating the valve.



Normally open—normally open V955 valves with a neutral position. Generally applied on double-acting cylinders where both sides of the piston are to be open to pressure when both coils are de-energized. Under certain conditions, the first operating stroke of double-acting cylinders will be smoother with this valve in use.



Normally closed—normally open V935 valves with no neutral position. Generally applied on double-acting cylinders where the piston is to be in retracted or extended position with pressure when both coils are de-energized. Wiring is simple—both coils are operated simultaneously and can be controlled by one single-pole, single-throw switch.



When you specify solenoid valves, specify Skinner. Skinner solenoid valves are distributed nationally.

SKINNER ELECTRIC VALVES®
THE CREST OF QUALITY

SKINNER ELECTRIC VALVES

SKINNER ELECTRIC VALVE DIVISION
SKINNER PRECISION INDUSTRIES, INC. • NEW BRITAIN, CONNECTICUT, U.S.A.

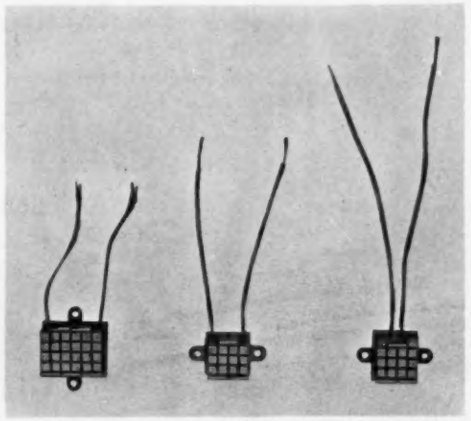
PRINTED IN U.S.A.

Thermoelectric Cooling/Heating Module 337

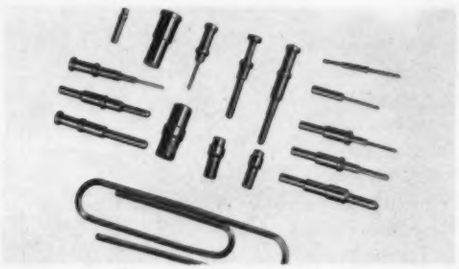
requires 90 percent less current

	Model 615	Model 629
Operating current (d-c):	0-3.5 amps	0-3.5 amps
Operating voltage:	0-2v d-c	0-4v d-c
Heat pumping capacity (maximum):	4.25w	8.6w
Maximum Delta T: (module mounted on 20C sink)		
in open air:	60C	60C
in vacuum:	74C	74C
Maximum operating temperatures:	−130 to 125C	−130 to 125C

Jepson Thermoelectrics, Inc., 139 Nevada St., El Segundo, Calif.



Microminiature Pins and Sockets 338



Miniature and microminiature pins and sockets are designed for use on printed-circuit boards and similar limited-space applications. More than 100 different configurations are obtainable. Providing high holding power, units accept wire diameters from 0.065 down to 0.010 inch. Pin sizes range from 0.017 to 0.060 inch in dia.

Omega Precision, Inc., 757 N. Coney Ave., Azusa, Calif.

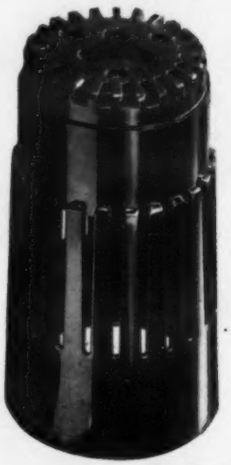
Circle 71 on Reader-Service Card

PRODUCT-DESIGN BRIEFS FROM DUREZ

- **Phenolic for wet-dry jobs**
- **Plastic in subway cars**
- **Structural adhesives**

Are you in hot water?

This washing-machine component has three jobs to do. It filters out lint from the wash load, adds detergents and



PHILCO CORPORATION

bleach powders to the wash water, and dispenses clothes conditioner or water softener into the rinse water.

Design of the part clearly indicated molded plastic for economical production. But it was essential to have a plastic that would stand long exposure to moisture, heat, and detergents, and provide a good-looking surface.

That's why *Durez 13856 Black* was selected. This flock-filled phenolic molding compound is especially formulated for parts in contact with water. It's widely used in pumps and valves—particularly when a part is to be wet on the inside and dry on the other. It has excellent resistance to detergents, acids, soaps, mild alkalies, and many solvents. Hot, sudsy water can't harm it. In addition, the material has the inbuilt ruggedness and durability of all phenolics—and is relatively low in cost per lb.

Light – and tough

Philadelphia expects to save $6.5 million over the 35-year life span of its 270 new subway cars.

Built of stainless steel and with one-piece end sections of glass-reinforced Hetron® polyester, the new cars save on power because they weigh about three tons less than conventional cars.

They won't ever need painting. End sections are dentproof and virtually shatterproof. The Hetron material retards fire, and corrosion isn't expected to be a problem.

Ends of the cars were made by hand layup at Modular Molding Corp., which delivered the first unit just one month from start of tooling. Section thickness and rigidity were controlled by adding extra plies of fibrous glass where needed during layup. Gray metallic color was molded in.

Hetron is tough enough for just about any structural assignment you want to give it. Inherent fire safety—

THE BUDD COMPANY

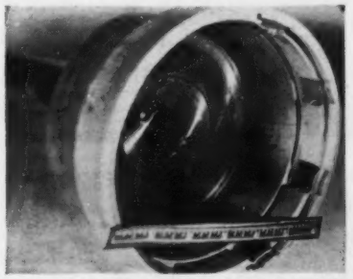
without loss of other physicals—qualifies it for many jobs other polyesters can't do. If you'd like facts on what's being done with Hetron today, just check the coupon.

Strong stickum

Are the old ways of joining metal and metal good enough for you? Then prepare for a mild shock as you look at this picture.

It's the housing of an automotive torque converter, joined to the output shaft by a thin film of thermoset cement. The converter has just undergone torsional tests that wrecked its mechanical parts—with no effect whatever on the metal-to-metal bond. Loud applause for the Cycleweld Chemical Products Division of Chrysler Corporation for this prodigious bond!

A similar cement, made of nitrile rubber and Durez phenolic resin, cut



CYCLEWELD CHEMICAL PRODUCTS DIVISION
CHRYSLER CORPORATION

the cost of assembling an all-aluminum truck tailgate from $15.18 to $1.75, by eliminating 211 rivets and 42 welds.

Other heat-setting cements show promise for:

- Building new strength and quietness into car doors, deck lids, and hoods by edge-bonding instead of tack welding.
- Attaching metal trim without drilling holes.
- Easy-to-cast aluminum engine heads and intake manifolds, made in two sections bonded together with a leak-proof, heatproof seal.

We don't make these super-stickers ourselves. We merely supply the phenolic resins that give them many of the qualities a good structural adhesive must have, including permanent rigid set and heat resistance. If you'd like to know where you can get adhesives made with our resins, we'll be glad to tell you.

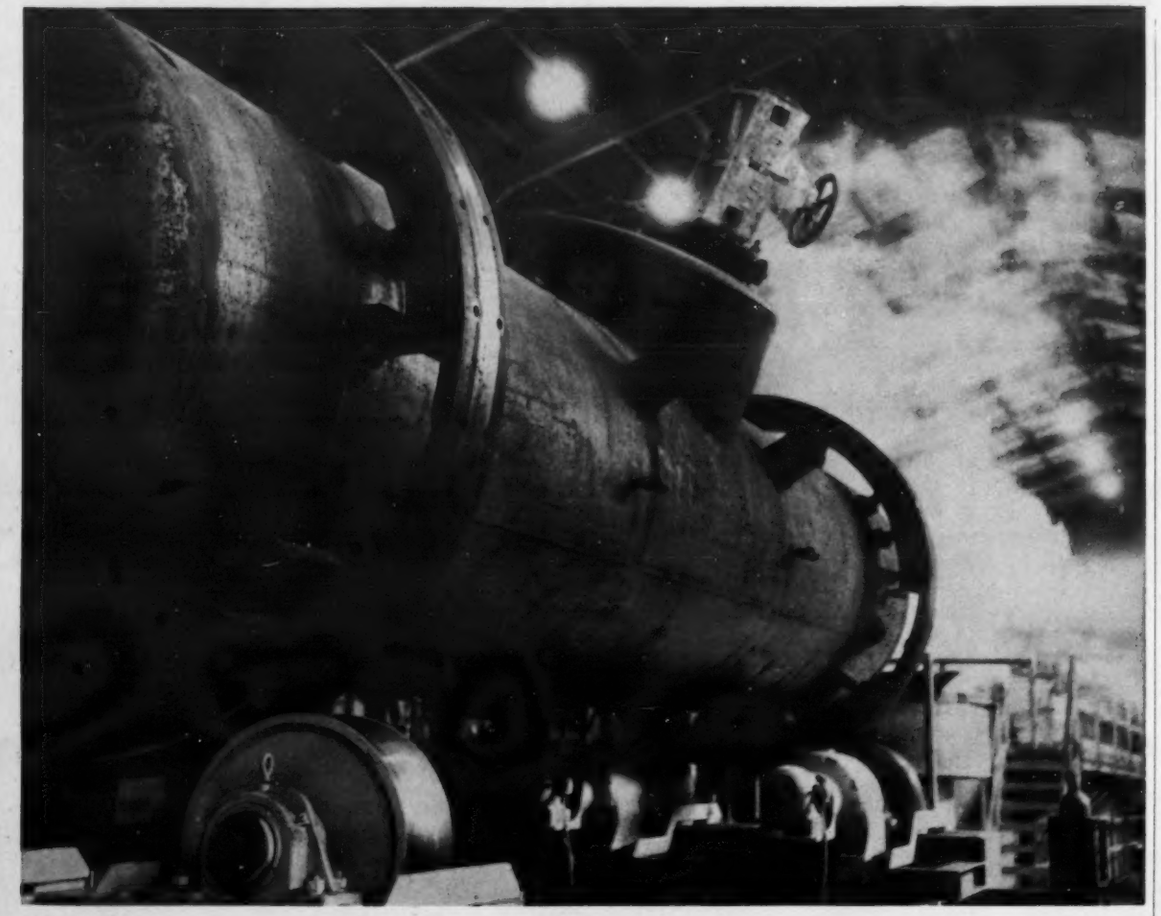
For more information on Durez materials mentioned above, check here:

- ☐ *Durez 13856 Black* phenolic molding compound (4-page bulletin)
- ☐ Hetron fire-retardant polyesters (designer's data file)
- ☐ "Durez Plastics News" (a review of current plastics applications, mailed bimonthly)

Check, clip and mail to us with your name, title, company address.
(When requesting samples, please use business letterhead.)

DUREZ PLASTICS DIVISION
2109 WALCK ROAD, NORTH TONAWANDA, N. Y.
HOOKER CHEMICAL CORPORATION
HOOKER CHEMICALS PLASTICS

Circle 72 on Reader-Service Card for more information



The specialists at General American's Kanigen plant in Sharon, Pennsylvania can deposit an even coating of hard nickel alloy on most ferrous metals in common use. Regardless of how high, wide or heavy the object is, if you can get it to Sharon, we can plate its interior.

Before General American developed Kanigen coating, it was next to impossible to deposit an even nickel plating over very large surfaces or on many complex shapes. Since Kanigen nickel plating is purely a chemical process involving no electric current, it works equally well on simple or complex shapes and on small or large surfaces. Thickness uniformity of the coating is independent of part complexity or size.

Only General American and its authorized licensees around the world can show you how Kanigen coating may improve your product. The Kanigen process is protected by more than 30 separate patents. For detailed technical literature, write for bulletin No. 561.

IF YOU CAN SHIP IT WE CAN PLATE IT!

NO MATTER WHAT THE SIZE OR SHAPE OF YOUR PRODUCT, IT CAN BE COATED BETTER WITH KANIGEN® NICKEL ALLOY

Kanigen Division

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street, Chicago 3, Illinois *Offices in principal cities*

KANIGEN GENERAL AMERICAN TRADE MARK

Circle 73 on Reader-Service Card for more information

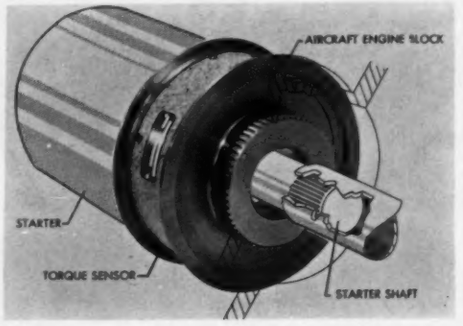
EQUIPMENT

Drafting Template 339

Developed to aid in drawing cross-sections and in specifying O-rings and O-ring grooves, this template also carries dimensional and tolerance information as well as other technical data useful to designers, engineers and draftsmen. Pocket-sized, semi-opaque and made of nonglare plastic, the template has cutouts to duplicate the cross-section pattern of rings and grooves in actual size, double size and quadruple size.

Parker Seal, Co., 10567 Jefferson Blvd., Culver City, Calif.

Torquemeter 340



Direct torque measurement of starters, pumps, gear boxes, turbines and other high-speed rotating machinery is a design application of this instrument. Model 2302 Coaxial Torque Sensor measures torque by restraining the case of the test unit. This provides true dynamic torque with good frequency response by eliminating need for in-line sensors which change the rotating inertia of the system being tested. The meter can be used in any position, making it suited for production checking of assembled systems under actual operating conditions, including testing of aircraft starters in flight. There are no slip rings, brushes or moving parts in the device. Standard models are offered in capacities of 200 to 2000 lb-in with accuracies of 1/4 percent.

Lebow Associates, 14857 W. Eleven Mile Rd., Oak Park 37, Mich.

Ratchets 341

Strength, simplicity and serviceability are increased in this newly designed line of ratchets. Use of a small, oil-resistant, "Neoprene" rubber plug inside ratchet eliminates need for complicated and fragile springs normally used to actuate and hold in position the pawls of a ratchet. A total of only seven parts makes up the new unit, allowing it to be field stripped with a pocket knife and reassembled easily. The units are offered in 1/4-, 3/8-, 1/2- and 3/4-inch square drive models.

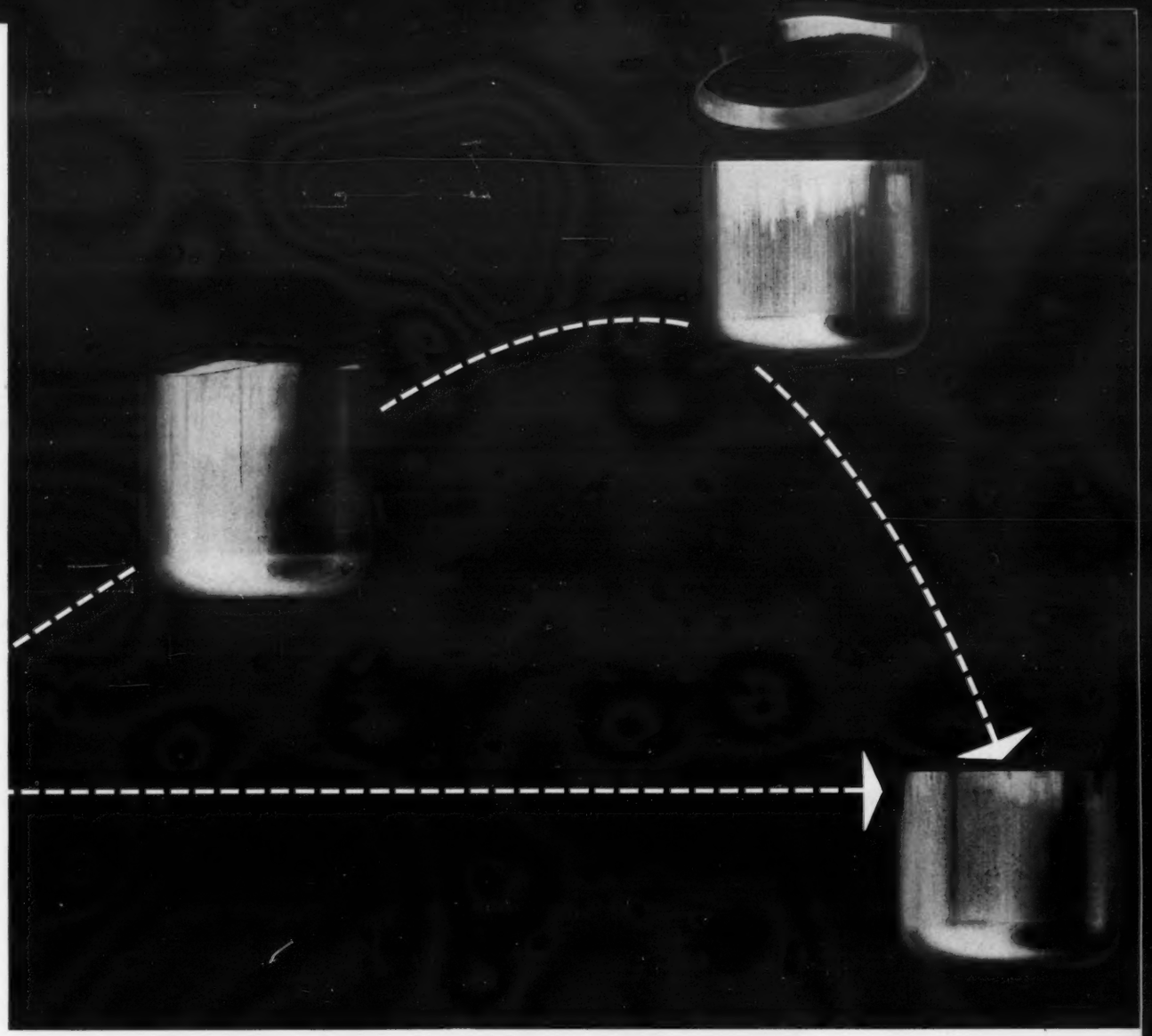
Crescent Tool Co., Jamestown, N. Y.

Marine Channel Kit 342

Of interest to marine craft designers and marine window manufacturers is a kit containing samples, blueprints, specifications and prices of woven wool pile glass-run window channels. Several shapes, types and sizes are covered, as well as the manufacturer's weatherstripping. Samples include single and double U-shaped, metal-backed channels; flexible-wire, flat shaped, and U-shaped channels, and metal-backed flat shapes. Backing is noncorrosive stainless steel, aluminum or interwoven wire. Pile heights range from 0.100 inch.

Schlegel Mfg. Co., Dept. MC, Rochester, N. Y.

Circle 74 on Reader-Service Card



ARE YOU TAKING THIS COSTLY PRODUCTION "DETOUR"?

The problem is a common one in steel drawing operations: How to eliminate scalloping or "ears"?

One way is to trim them. The other is to eliminate them—at the purchasing stage.

You can do this by specifying J&L Precision Non-Scalloping cold rolled strip steel. Through precise control of every production step, J&L has developed a low carbon strip *which is non-scalloping.*

Result: a major operation—trimming—can be saved. Also, you'll have fewer rejects and less down-time. These advantages mean more profitable production—and are especially important in operations involving progressive dies, where uniformity and protection of equipment are major factors.

Steel

Non-scalloping strip is just one of the full line of precision products backed by J&L's combination of specialized equipment and techniques, plus *experience.* For information, call your J&L Stainless and Strip Division representative or write to Dept. 1360.

J&L STRIP

LOW CARBON • HIGH CARBON • ALLOY • STAINLESS
TEMPERED SPRING STEEL • ZINC AND COPPER COATED

Jones & Laughlin Steel Corporation • STAINLESS and STRIP DIVISION • Youngstown 1, Ohio

Tube Base Adapter **343**

This device will accomodate three new tube bases, the 9-pin Novar, the 12-pin Compactron and the new 10-pin tube base. The size of the adapter is 3-1/2 inches long by 2-3/8 inches wide by 3/4 inch high. It can be carried in the cord compartment of the Model 107 tube tester. The 107 adapter comes complete with 22-inch 12-wire cable ready for simple installation. Set-up data on new tubes also is included.

Seco Electronics, Inc., 5015 Penn Ave. S., Minneapolis 19, Minn.

Precision Microscope **344**

A precision measuring instrument provides a method which increases die life and reduces production costs. The "Die-Wear Microscope" determines the exact amount of metal which must be ground away to properly resharpen the cutting edge. The unit is capable of measuring die-wear over a range of 0.020 inch to an accuracy of ±0.0005 inch or 10 percent of the depth, whichever is greater. Compact in design, the instrument can be hand-held or supported on its own base. Additional uses include measuring of bevels, burrs and fillets. The device may be purchased as a battery-operated unit or with an accessory transformer for use where 115v, 60-cycle a-c outlets are available.

Bausch & Lomb Inc., Rochester 2, N.Y.

Circle 75 on Reader-Service Card

Who else wants to save $100,000 this year?

How the Revere Technical Advisory Service Showed a Metal User the Way to Profit-Protecting Economies — and can do the same for you!

A leading manufacturer—you'd recognize the name immediately—is a heavy user of copper and its alloys. It buys sheet, strip, tube, rod—by the hundreds of tons. Recently, this company invited the Revere Technical Advisory Service to inspect its operations, study its metals needs, analyze its buying practices and look into its specifications. The Revere people were actually treated as members of the crew at the company's plants; nothing pertinent was kept secret, no knowledge hidden.

The result? Recommendations all down the line on every phase of copper and copper alloy procurement and use—and production savings made possible in every area. The Revere Technical Advisor actually showed the way to an astonishing potential saving . . . well over $100,000 yearly!

Naturally, not every company can expect such huge savings. Too many variables enter in. But *if* detailed knowledge of metals, their manufacture and their uses can be applied to *your* product and *your* production, the Revere Technical Advisors are at your service. These are the men who know non-ferrous metals best—and many other metals equally well. They are ready to serve you—*now*.

You can reach the Revere Technical Advisory Service simply by calling or writing the Revere Office nearest you. If you are interested in a cooperative program of this kind and in discussing your metals procedures fully—in confidence—call Revere today. You will find that you have taken the first step toward profit-protecting economies. No obligation, of course.

REVERE

COPPER AND BRASS INCORPORATED

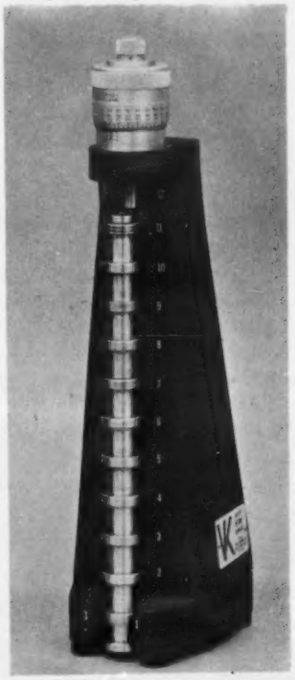
Founded by Paul Revere in 1801

Executive Offices: 230 Park Ave., New York 17, N. Y.

Mills: Rome, N.Y.; Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles, Riverside and Santa Ana, Calif.; New Bedford and Plymouth, Mass.; Brooklyn, N.Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities.

Distributors Everywhere

Height Gage 345



A 12-inch height gage offers a completely new feature—the opportunity to measure a dimension smaller than one inch. The unit will measure from a range of 0.250 to 12 inches, accurate to 0.000050 inch on any measurement. The ability to set any dimension to 0.0001-inch steps from 0.250 inch to 12.000 inches enables the operator to set exact dimensions (the manufacturer states), eliminating the need of wringing gage blocks. A spring-loaded nonrotating measuring column consists of a series of 0.250- and 0.750-inch spacers lapped to gage-block accuracy. Since the spacers are lapped flat and parallel, the inspector can take readings from either top or bottom side of spacers. Because of springloaded construction of measuring column, all chance of backlash is eliminated.

The Van Keuren Co., 180 Waltham St., Watertown 72 Mass.

Circle 75 for Reader Service

Electromechanical Application Kit 346

A prototype kit is available to provide the design engineer with fast answers to numerous problems of system stabilization, vibration damping and time delay. It allows the user to rapidly select, set up and observe more than 15 different damping effects. Three "Airpots" form the basis of the kit and offer a choice of damping modes for any foreseeable application: 2-way, 1-way pull and 1-way push. Each unit is constructed of a low-expansion glass cylinder, precision-fitted with a carbon piston to tolerances closer than 0.0002 inch. A color

code assures that the correct piston is inserted into its matching cylinder. After damping mode is selected, there is a choice of five different coupling springs to link damping action to the device or system. One is for direct linkage, while others have various spring gradients to modify frequency and phase characteristics of the system. A kit manual, "Airpot Application Information", will be sent free of charge on request.

Electric Regulator Corp., Pearl St., Norwalk, Conn.

Designers think of R/M first for asbestos, rubber,

Poly-V "J" Light Duty Drive Gives You Design Advantages Never Before Possible

Most Revolutionary Drive for Small Sheaves, Short Centers, Compact Units

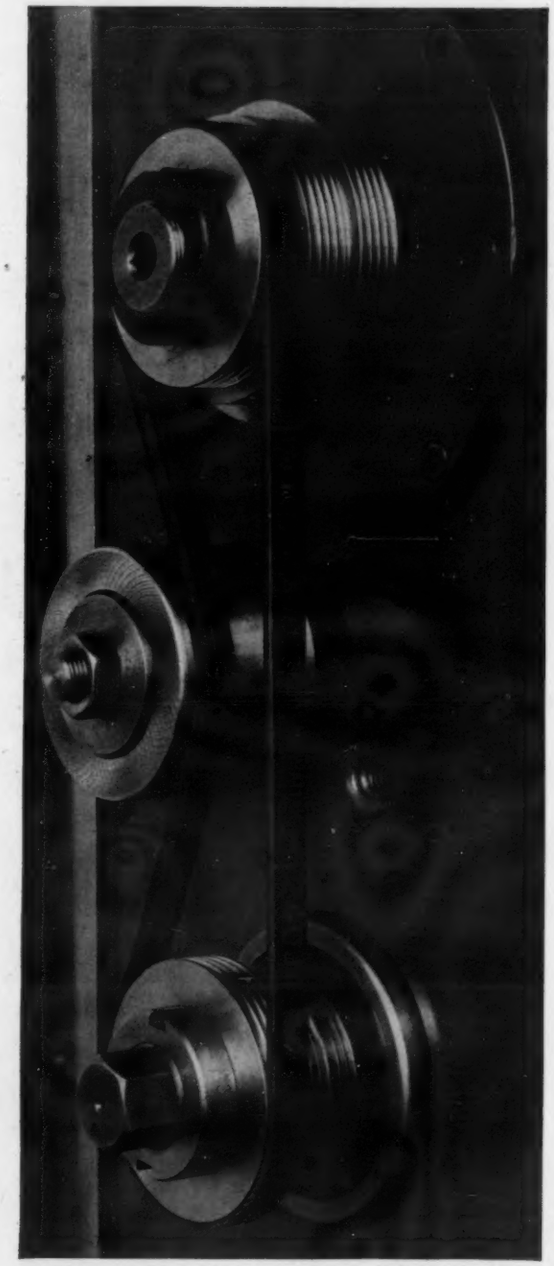
R/M POLY-V® "J" DRIVE is industry's newest and most revolutionary light-duty drive for small diameter sheaves, short centers and compact units. It utilizes a single parallel V-ribbed belt running on space-saving sheaves grooved to mate precisely with the belt ribs. Design advantages of Poly-V "J" add up to more dependable power in less drive space wherever balance and highly efficient, silent, vibration-free drive performance are required.

Advantages

- **Designed especially for small sheaves; considerably below V-belt range**
- **Silent, vibrationless, cool operation; homogeneous traction surface is spliceless, lapless**
- **No belt matching; a single belt cross section meets every need from 1/40 to 15 HP**
- **Delivers much more load in less space; permits more compact drive with smaller mounting clearances**
- **Exceptional flexibility; operates easily with midget motors**
- **Ideal for tandem, mule, ¼ turn or serpentine drives; with reverse bend idlers and for speeds up to 10,000 f.p.m.**
- **Minimum drive wear; assures longer belt and sheave life**
- **Absorbs shock; overload slip protection against machine damage**
- **Complete contact pressure; maintains groove shape**
- **Heat and Oil Resistant**

Poly-V "J" has been proved for smooth, silent power service on a wide range of small machinery—home workshop, machine tools, wash machines, lawn mowers, household appliances, and for many types of industrial, commercial and scientific machines.

For medium and heavy duty drives, R/M Poly-V* is available in the larger "L" and "M" Sections. These 3 Poly-V Belts (J, L and M) will replace 8 V-belt size sections and cover a power range from 1/40 to 1700 HP. Wherever your design problems involve power transmission drives, V-belts, flat belts . . . rely on R/M products and engineering.



Poly-V "J" on Parker Majestic Grinder as standard equipment

RUBBER

Write today for free booklet shown: full details on a wide variety of industrial rubber products. Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N.J.

Circle 76 for more information on Rubber

sintered metal, and engineered plastic products

BOND FAILURES CAN BE PREVENTED!

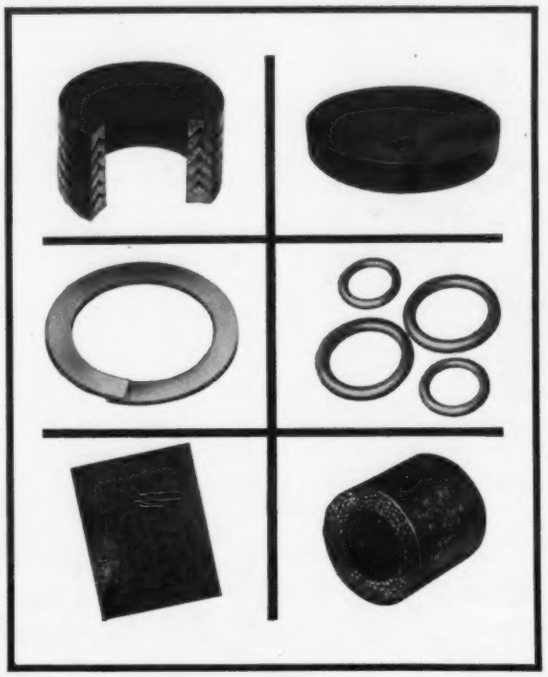
Here's how to stop 13 of them . . .

Type of Failure	Solution
THERMOSETTING ADHESIVES	
• Cohesive failure	Check film with solvent used in adhesive. If solvent softens the adhesive film or becomes tacky, this indicates insufficient cure. Make sure bond line time and temperature is used.
• Adhesive failure from metal	If metal surface has a white, clean appearance, check cleaning technique.
• Adhesive failure from substrate other than metal	Try prime coat of diluted adhesive, also check compatibility.
• Cellular areas in adhesive line	Increase pressure and/or adhesive.
CONTACT ADHESIVES —room temperature setting	
• Tacky film	If film should dry hard but remains tacky, the cause may be entrapped solvent or migration of plasticizer from one substrate.
• Shiny areas	Poor contact, insufficient pressure or insufficient amount of cement.
• No bond	If heat reactivated type, adhesive was too cool at time of assembly or poor compatibility.
• Failure in adhesive from metal	Improper cleaning.
• From substrate other than metal	Incompatible or unclean surfaces.
HOT MELT	
• No bond	Incompatibility, adhesive too cool at time of assembly. Parts too cool at time of application of adhesive.
EPOXY BASE ADHESIVES AND CASTING COMPOUNDS	
• High exotherm	Mix lower volume and pour mixed material into shallow tray. Cool base and activator before mixing or use Metermixing equipment.
• Tacky film or casting	Improper base activator ratio, improper mixing of base and activator, improper cure. Check bond line temperature.
• Flexible casting or film of rigid adhesive or casting compound	Improper mixing of base and activator, improper base and activator, improper cure. Check bond line temperature.

Bond failures can be prevented! Raybestos-Manhattan's adhesive experts also have solutions to less common causes of bond failures . . . based on more than 20 years' experience in the production of bonded assemblies and the manufacture of adhesives, coatings and sealers. Why not call on them today for the answers to your adhesive problems—no cost or obligation, naturally.

ADHESIVES

Get helpful engineering information on selecting, bonding and testing adhesives. Write today for your free copy of Bulletin No. 701. Adhesives Department, Raybestos-Manhattan, Inc., Bridgeport, Conn.



R/M CAPABILITY PRODUCES REINFORCED TEFLON PACKINGS

to lower friction, eliminate contaminating lubricants, resist corrosion and extrusion

Now you can get "Teflon" packings with the exact mechanical properties you require. R/M capability has developed a host of reinforced Teflon packings, one or more of which may meet your requirements.

Among these are Vee-Flex® rings, piston cups, gasket materials, and specially machined and molded products. Each is designed for a specific application—using the advantages of Teflon coupled with the advantages of other materials.

R/M's broad experience in design, compounding and manufacturing of mechanical packings and gasket materials is at your disposal. Send data on your specific application.

PACKINGS

Write for new catalog giving complete information about Reinforced Teflon Products and other R/M packing and gasket materials.

RM 110

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • Fullerton, Calif. • No. Charleston, S.C. Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada

Circle 77 for more information on Adhesives

Circle 78 for more information on Packings

Power Meter 347

This device may be mounted directly on the shaft of a rotary component, transmitting readings to a remote location without wires, slip rings or other physical connections to give accurate readings of shaft horsepower. The device weighs only 3-1/2 lb, requires no maintenance and costs little to operate. Horsepower readings are extremely accurate (within one percent). A miniature FM/FM transmitter is utilized for noise-free operation and complete, solid-state electronics for the radio-telemetry portion of the system. Electronically sensed torque-and-rpm signals are mixed and amplified. This intelligence then is used to cause a

frequency deviation of a subcarrier oscillator. Output from this oscillator is fed to an FM transmitter and then to the antenna. The signal is received by a VHF-FM receiver. It then is discriminated to obtain the subcarrier frequency and discriminated again to produce an output signal proportional to frequency deviation. Output signal is amplified and applied to the readout recorder. Speed, size and location of shaft determine basic packaging concept for a particular application. A three-channel system is also available if a separate and direct indication of torque and rpm is desired.

Unilectron, Inc., 129 Binney St., Cambridge, Mass.

Put **PERMALI** into your design plans!

PERMALI

the laminate of many uses!

. . . as a non-metallic structural material — tensile strengths to 30,000 p.s.i.—parts to 13 feet long and 5 inches thick—tailored mechanical properties to fit your needs—machines easily to engineering tolerances.

. . . as a dielectric—high dielectric strength—low power factor—used by every major heavy electrical equipment manufacturer.

. . . as a non-metallic fastener—available off the shelf as studs, continuously threaded rods or bolts with matching square or hexagon nuts.

. . . as a silent gear—special grade gives uniform tooth strength. Diameters to 48″, face widths to 4″.

. . . as thermal insulation at very low temperatures—Permali retains most of its mechanical strength at the temperature of liquid gases.

. . . as a neutron shield—a special grade provides structural strength while shielding against fast neutrons.

And Permali, Inc. can design, machine or build your parts or structures regardless of size.

Technical literature on any or all the above applications available on request to

PERMALI, Inc.

P. O. Box 718
Mt. Pleasant, Pa.

Telephone: KImball 7-2353

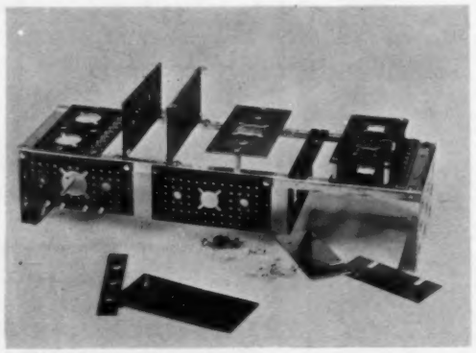
TWX: MT PL PA 161

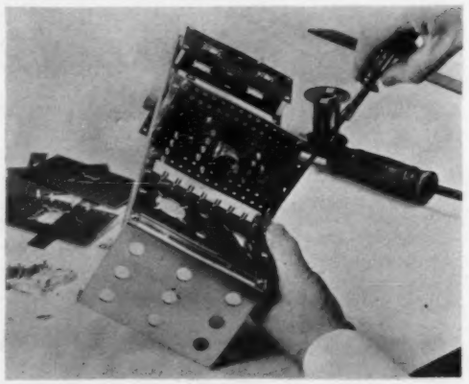
Circle 79 on Reader-Service Card for more information

EQUIPMENT

Breadboarding Kit 348

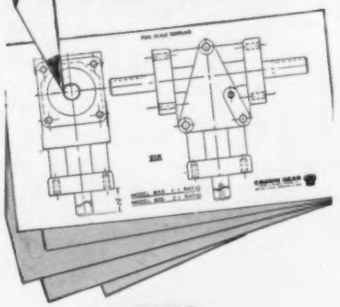
Assembly of prototypes of electronic equipment now can be accomplished without using any power tools except a soldering iron. The "3-D" kit is comprised of prepunched, laminated-phenolic panels; terminal and volume-control strips; silver-plated, snap-in, turret terminals; punched chassis frames; end plates and rack-mounting plates and an assortment of hardware. Panels have holes for both miniature and octal tube sockets, for potentiometer-shaft bushings and for the snap-in terminals. Terminals are designed to be pushed into panels and hold securely without turning. They extend far enough through panel for wiring connections to be made on both sides. Chassis frames are 16-7/8 inches long and with mounting plates will fit standard 19-inch racks. Angle brackets and standoffs allow panels to be grouped.



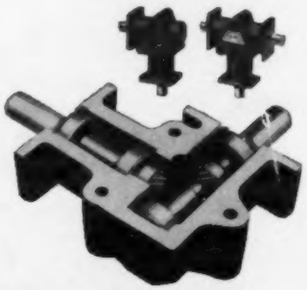


Precision Metal Products Co., 41 Elm St., Stoneham, Mass.

THESE TEMPLATES...



THIS CROWN "PACKAGE"



wrap up your right-angle design problem!

. . . And the transition to the "Package" concept of right-angle power transfer is **that** simple with this easy-reference template kit. 18 basic Crown right-angle units are shown on six template sheets, each full scale.

WHY spend countless hours on research and drawings? **WHY** purchase expensive patterns, core boxes, castings, steel and other materials? **WHY** manufacture fixtures and gages? **WHY** machine, inspect, assemble and test components?

WHY NOT OBTAIN THE IDEAL SOLUTION TO YOUR RIGHT-ANGLE PROBLEM . . . IMMEDIATELY, AND AT TREMENDOUS SAVINGS?

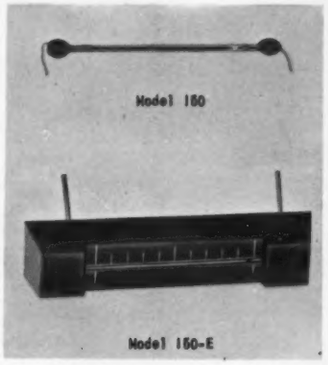
Your local Crown Gear Distributor (Listed in Power Transmission Design Directory) has the answers . . . and your Template Kit. Call him or consult factory.

CROWN GEAR

320 PARK AVE., WORCESTER 10, MASS.
A Division of Harrington & Richardson, Inc.

Circle 80 on Reader-Service Card

Ampere Hour Meter 349



A miniaturized ampere hour meter has been developed for military and industrial applications where space and weight saving are of primary importance. Model 150 consists of a drawn capillary glass tube containing a mercury anode separated from a mercury cathode by liquid electrolyte gap. Under applied voltage, current flow transfers mercury quantitatively across the electrolyte, giving linear displacement of the gap down length of tube. The device is a direct-reading microcoulometer that measures 1-1/2 inches long by 0.050 inch OD, with an active scale length of one inch. Two wire electrodes are mounted at the anode and cathode of the meter. It can be positioned, either vertically or horizontally, on the instrument or component being timed. The unit has passed MIL-E-5272C for both vibration and shock, and has an operating temperature range of −30 to 110C, with a storage temperature range from −60 to 125C. It operates on d-c or pulsed d-c signals with any wave form. The device generally requires a ballasting series resistor when operating from standard battery power supplies. It has an intrinsic meter resistance of 200 to 300 ohms and has essentially no temperature coefficient due to ballast resistor requirement. The meter has a rate of movement of 0.096 inch per milliamp hour and will operate with currents up to 250 microamps.

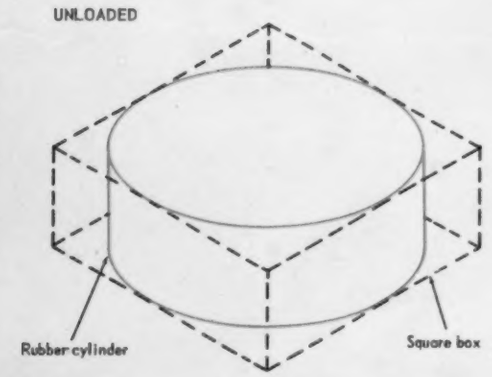
Curtis Instruments, Inc., 45 Kisco Ave., Mount Kisco, N. Y.

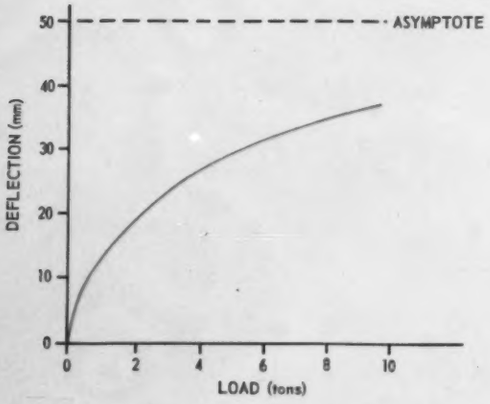
Circle 81 on Reader-Service Card

YOURS
FOR THE
ASKING...
over 80,000
prop blade
combinations!
...and all at standard production run prices too. No expensive engineering or tooling costs to absorb. You name the application; electronics, heating, cooling, general appliances and Meier has a quality built propeller blade for it. Let Meier evaluate your product's impeller requirements in their own testing laboratory (no obligation, of course) and recommend the most efficient, economical prop blade you can use. Sample blades on request.
Meier
DIVISION
THE LAU BLOWER COMPANY
3525 East Washington Street • Indianapolis 7, Indiana

Rubber Cylinder in Square Box Provides Progressive Elastic Properties

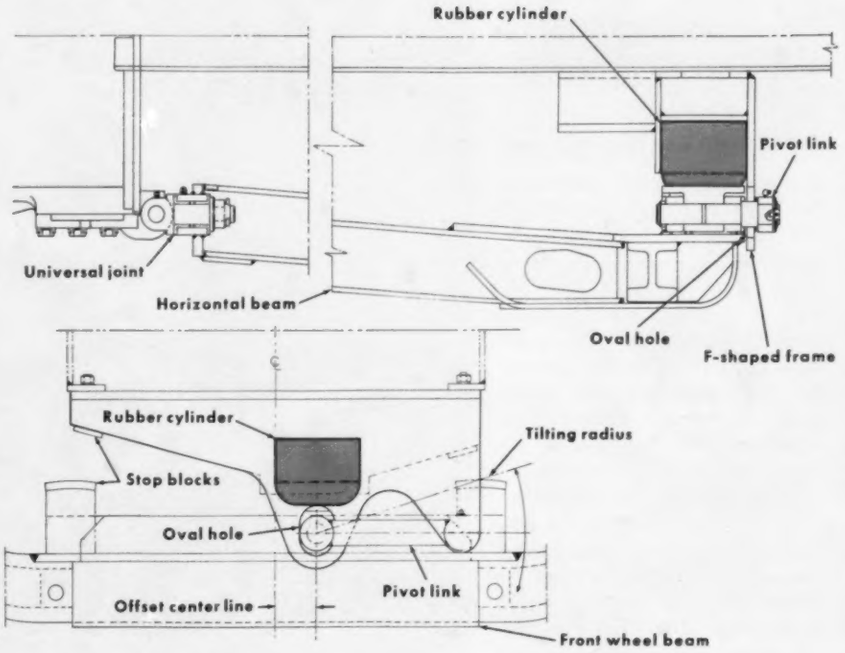
Volrath Holmboe, Correspondent in Sweden

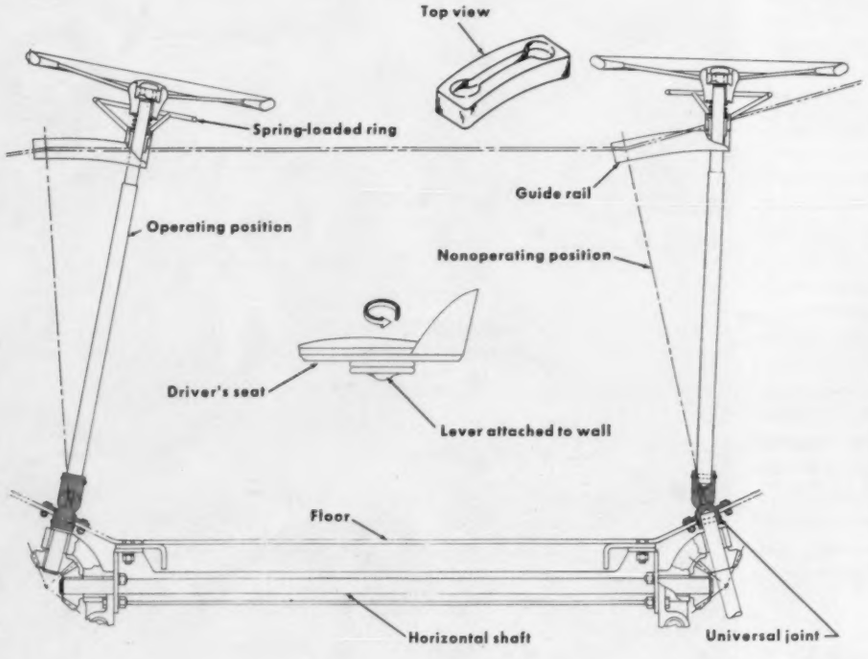




COMPRESSION OF RUBBER CYLINDER is guided in square metal box which is open in lower end. When load is applied, rubber expands into corners of box and approaches asymptotically shape of box as load is increased. Small increase in load at small loads causes same deflection as larger increase at large loads.

LOAD ON FRONT WHEELS is transmitted through rubber cylinder. Deflection is restricted to 50 mm by oval hole in F-shaped frame. Tilting is limited to about ±10 deg by stop blocks. Front wheel unit is hinged to chassis by pivot link between F-shaped frame and bolt through oval hole and by universal joint at rear end of horizontal beam. Rubber cylinder is slightly offset to right of center line to allow for effect of driver's cabin on center of gravity position.





UNIVERSAL JOINT at floor level permits each steering wheel to be tilted along guide rail. Spring-loaded locking ring fits into holes in guide rail to keep steering wheel rigidly in desired position. Horizontal shaft just below cabin floor connects two steering wheels. Power steering of system "Hydross", built on German license, is adopted. Driver's seat may be turned 180-deg to serve either steering wheel.

A solid rubber cylinder, serving as spring and shock absorber, permits deflection and ±10 deg tilting of front wheels in a new dumper. The cylinder is located in a square metal box which is open in its lower end. When compressed, the rubber expands laterally into the corners of the box. The box also prevents the rubber from uncontrolled squeezing.

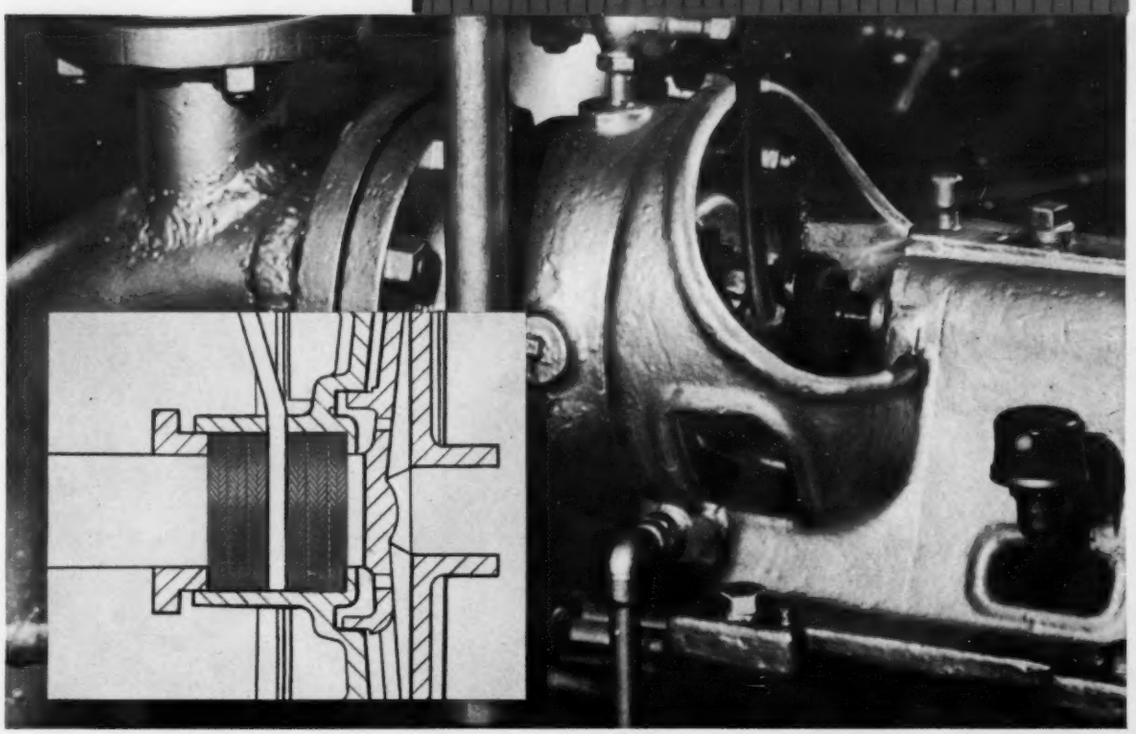
Progressive elastic properties obtained with the arrangement provide comfortable spring action and shock absorption through the entire load range as well as during tilting. Additional shock absorption is obtained from the hysteresis effect in the rubber. Oil-resistant rubber is used. Its life length is claimed to be at least as long as that of conventional steel springs.

With an overall length of only 5.025 meters, the dumper can carry a 6.5-cu m, or 10-ton load. Its turning radius is 7.5 meters.

The "Rockerman" dumper and its suspension system were designed by Akermans Verkstad AB, Eslov, Sweden.

DU PONT

TEFLON®



Pump packings of asbestos and TEFLON® TFE eliminated retightening...replacement...shaft damage

CAN YOU AFFORD NOT TO USE TEFLON?

Packings made with TEFLON are your logical and most economical choice whenever severe environmental conditions are encountered, AND in all cases when you want—

... greatly reduced packing maintenance
... reduction of replacement costs
... reduced cylinder and shaft wear
... greater standardization with reduced packing inventories
... the competitive advantage of quality and dependability

If any of these considerations are important to your design, the choice of any other kind of packing material might well be wasteful.

DU PONT
REG. U.S. PAT. OFF.

Asbestos impregnated with a Du Pont TEFLON TFE-fluorocarbon resin is the packing material used in the condensate pump shown above. This centrifugal pump operates at 3500 rpm, returns condensate—water at 110°F. to 175°F.—to a de-aerating tower. It operates with a −9-ft. suction to a 45 psi head. Before packings made with TEFLON were installed, packings required retightening five times per year, replacement once a year. The new packings have been in service over five years ... have needed no maintenance ... and have eliminated the danger of scoring and abrasion resulting from squeeze-out of conventional additives.

Under more severe service conditions, TEFLON resins are often the only answer. These materials are inert to virtually all chemicals and solvents, at temperatures from −450°F. to 500°F.

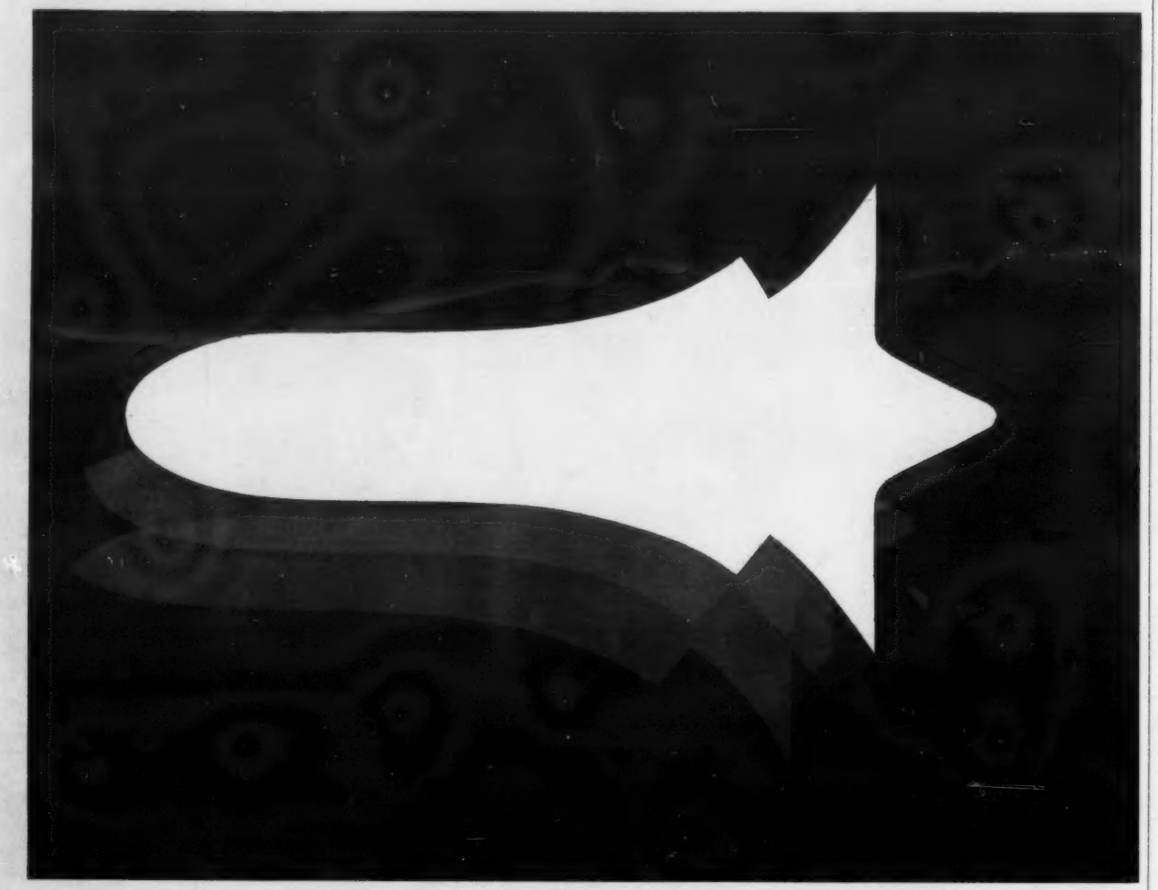
Consult your supplier about the many constructions available in packings made with TEFLON. Write for the new booklets: "Packings for Valves and Pumps" and "Designing with TEFLON". Address E. I. du Pont de Nemours & Co. (Inc.), Dept. DN-929, Room 2507T, Nemours Building, Wilmington 98, Delaware. **In Canada:** Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

TEFLON®
FLUOROCARBON RESINS

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.

BETTER THINGS FOR BETTER LIVING ... *THROUGH CHEMISTRY*

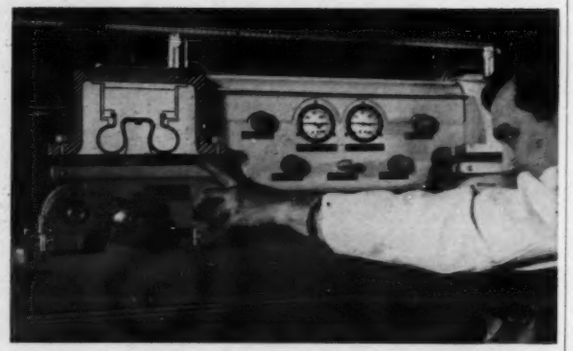
Circle 82 on Reader-Service Card for more information



How to float a nose cone on fingers of air

Firestone Airmount facilitates missile assembly, cradles parts into precise alignment

Easy does it at General Electric's Missile and Space Vehicle Department when 5,000-lb. nose cones—cradled on Firestone Airmount-cushioned carriages—are positioned for missile assembly. The Airmount functions on the handling and mating cradle as combination spring and actuator. Utilizing its very low rate, or spring constant, one man can manually "nudge" the dead weight into exact alignment for a perfect fit with the mother missile. This is only one of many ways Firestone Airmounts meet industry problems with low-cost, long-term solutions. Whatever your actuation, suspension, shock or vibration problem, why not write us, Dept. 42-4, for a low-cost, long-term solution with Firestone Airmounts.



This technician, aided by Firestone Airmount, exerts only 25 pounds of manual effort to move a 5,000-pound nose cone into "mating" position on a missile carriage.

Copyright 1961, The Firestone Tire & Rubber Company

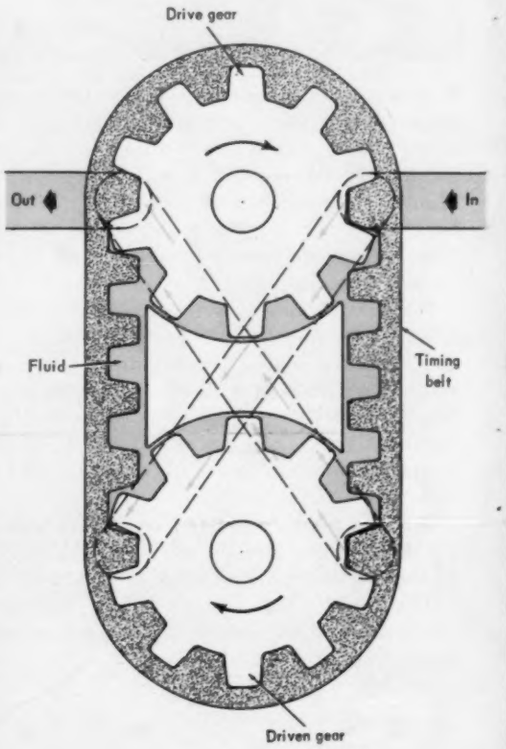
Firestone

INDUSTRIAL PRODUCTS COMPANY

Noblesville, Indiana • AIRMOUNTS® FOR INDUSTRY

Timing-Belt Gear Pump

Lars G. Soderholm, Midwest Editor



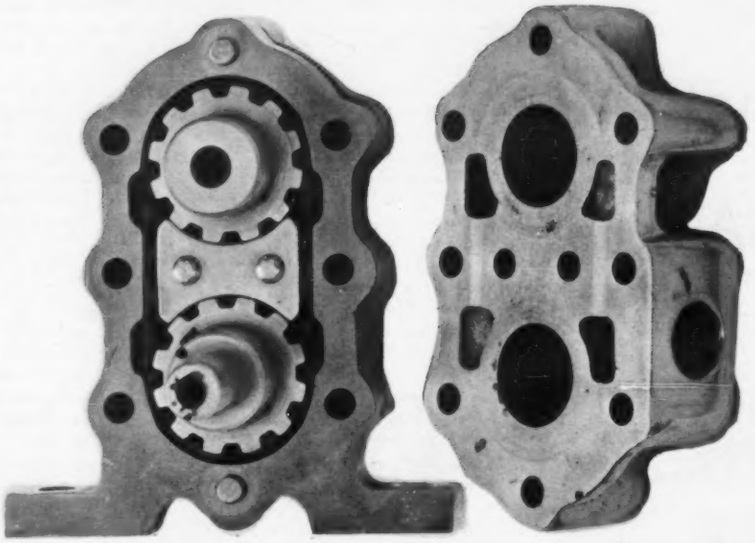
A notched timing belt is used to connect the drive and driven gears in an otherwise conventional gear-type pump. One portion of the fluid is transferred from the low- to high-pressure sides of the pump between the gear teeth while another portion of the fluid is transferred between the notches of the timing belt. Since the gear teeth do not mesh, much quieter operation is possible.

Initial design considerations were for pressure ratings in the 0- to 200-psi range. Lab tests have been successfully run up to 1000 psi. The flow rate of the pump can be varied depending on the gear size and width. Flows up to 100 gpm appear feasible at this time.

Potential applications would appear to be for domestic water systems, utility pumps, liquid fertilizer pumps and for home appliances.

The timing-belt gear pump is manufactured by Roper Hydraulics, Inc., Aviation Products Div., Rockford, Ill.

Provides Increased Capacity

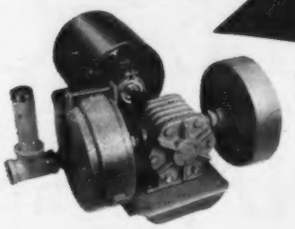


TIMING-BELT GEAR PUMP isolates two gears with close fitting separator. Opposite sides of each gear are interconnected by diagonal ports which in turn are connected to pump inlet and discharge connections. At point where timing belt leaves gear, small quantity of fluid is trapped and carried between teeth of gear and also between teeth of timing belt. This dual transportation of fluid provides double capacity over similar sized conventional gear pump.

Condé

Rotary, Positive Displacement

DRI-AIR PUMPS



PRESSURE OR VACUUM

- ★ Require no lubrication
- ★ Vibrationless
- ★ Long service life
- ★ Quiet
- ★ 5 models— 2.5 to 60 cfm capacities

Compact, versatile, rugged, dependable. Deliver clean dry air. Unlimited uses in O.E.M., plants, processing systems, labs, etc. Patented design and unique assembly guarantees efficiency, satisfaction, longer life. Vacuum or pressure to practical limits. Complete units as shown, also individual pumps and vapor lubricated models available.

Write for catalog #361 containing complete specifications.

Condé PUMPS, DEPT. D SHERRILL, N. Y.

Circle 85 on Reader-Service Card for more information

Just Out! Just the ticket to cut cost!

ROSS "CUB"

CUB

NEW SPEED CONTROL VALVE

1/8" and 1/4" pipe sizes in stock now!

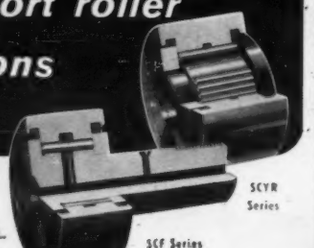
Now a speed control valve that regulates your cylinder movement with precision and sureness, but which lists at $3.00 and $3.25. And despite its lower costs, "CUB" features the same high quality of design and workmanship you've come to expect from Ross. "CUB'S" design stresses trouble-free operation and easy maintenance. CUB is small, aluminum and lightweight. If you use speed controls, by all means call your Ross representative or write us.

ROSS OPERATING VALVE CO.

106 E. Golden Gate Ave. • Detroit 3, Michigan

Circle 83 on Reader-Service Card for more information

Protected performance in cam follower, guide and support roller applications



Sealed and pre-lubricated McGILL CAMROL® bearings

Protect your roller follower applications for longer life with sealed CAMROL bearings. McGill packs high load capacity, precision accuracy, and positive seals into standard bearings. Avoid building up special units. The SCF series is complete with integral stud. In the SCYR series an inner race provides for shaft mounting. Black ferrous oxide finish adds corrosion resistance. Roller diameters range from 3/4" to 4".

Write for helpful Bearing Handbook No. H-62

engineered electrical products

McGILL®

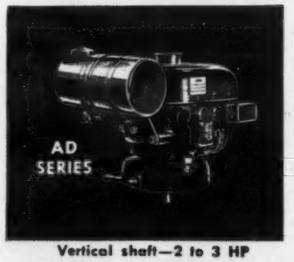
precision needle roller bearings

McGILL MFG. CO., Bearing Div., 203 N. LAFAYETTE ST., VALPARAISO, IND.

Circle 84 on Reader-Service Card for more information

ANY PRODUCT IS BETTER WITH CONTINENTAL RED SEAL POWER

Horizontal Shaft. Also available with 6:1 gear reduction (AR Series)—2 to 4 HP



Vertical shaft—2 to 3 HP

. . . because Continental air-cooled engines are built up to a standard of excellence, not down to a price. Their rugged design and construction assures long dependable service with minimum down-time. Backed by a world-wide service organization.

Continental Motors Corporation

INDUSTRIAL AIR-COOLED ENGINE DIVISION

12800 KERCHEVAL AVENUE • DETROIT 15, MICHIGAN

CONTINENTAL MOTORS — Power for the Nation's Needs — AMERICA'S STANDARD

Circle 86 on Reader-Service Card for more information

New Low Cost *MINA bearings

ACTUAL SIZE

ACTUAL SIZE

New low cost **MINA** bearings meet economic and technical problems in miniaturizing a wide variety of industrial and commercial products.

***MINA** bearing is the trade name for high quality ABEC-3 precision miniature bearings made in the U.S.A. by MINA Bearing, a division of MPB, Inc.

Write or phone today for catalog and prices.

MINA
BEARING
A DIVISION OF MPB INC.
KEENE, NEW HAMPSHIRE, U. S. A.

telephone: ELmwood 2-0310

Circle 87 on Reader-Service Card for more information

NEW LITERATURE

To obtain copies of numbered literature . . . circle appropriate number on Reader-Service card.

'Plexiglas' Handbook — 451

Provides technical information on the design, fabrication, lighting and assembly of signs made from "Plexiglas". Sheets, formed panels and letters are included. Tables provide colors, standard sizes and thicknesses of colored sheets and colorless transparent sheets. Basic design principles discussed include allowance for thermal expansion and contraction, provision for sheet deflection and structural requirements for sign frames. Design and construction details are provided for corrugated "Plexiglas" panels, mounting letters to the panels, and flat and corrugated panels. The new "Plexiglas" channel system for large luminous sign faces is explained. Twenty pages of the handbook are devoted to fabrication of the material. Sign lighting tables give recommended sign panel colors, brightness, percent light transmission, location of tube sockets and relative readability of various colored letters on white, ivory and yellow backgrounds. Other tables provide data on recommended light sources such as fluorescent lamps, cold-cathode lamps and fluorescent tubing. Final sections of the reference discuss maintenance service on "Plexiglas" signs, fabrication equipment and sources of supply for sign parts and equipment. Rohm & Haas Co., Washington Sq., Philadelphia 5, Pa.

Silicone Fluids — 452

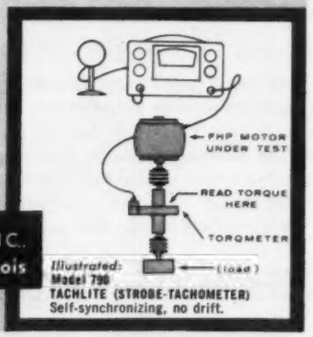
Silicone fluids and their contribution as hydraulic and damping fluids, dielectrics and lubricants, antifoam agents, coatings for ceramics and glass and as additives in urethane foams are described in technical reference No. S-9. The 20-page publication differentiates among available grades of silicone fluids, according to viscosity, and classifies them on the basis of physical properties. An index aids selection of a particular fluid on the basis of properties required in an application. Features of the reference include a physical data summary chart for easy identification of major grades of materials available and a silicone fluid selector which identifies available silicone fluid grades by major application areas. General Electric Co., Silicone Products Dept., Waterford, N. Y.

SENSITIVITY UNEQUALED with FHP TORQMETERS

For ACCURATELY MEASURING Rotating and Static TORQUES of FHP motors, gear-train efficiencies, ball bearings, servos, synchros, potentiometers, hair springs, and many other applications and devices.

We invite your inquiry for complete information and prices . . . or, send your specifications and application needs.

Illustrated:
Model 783 OZ-TORQMETER
measures from .05 to 80 oz.—inch
Also available:
Model 782 GRAM-TORQMETER
measures from .25 gm-cm to 100 gm-cm
Model 784 POUND-TORQMETER
measures up to 200 lb. — inch
Model 781 GRAM-TORQMETER
measures from .05 gm-cm to 5 gm-cm



Illustrated:
Model 790
TACHLITE (STROBE-TACHOMETER)
Self-synchronizing, no drift.

POWER INSTRUMENTS, INC.
7352 North Lawndale Ave. • Skokie, Illinois

NOTE: A few choice territories available for experienced representation.

Circle 144 on Reader-Service Card for more information

'Delrin' Acetal Plastic **453**

Properties and applications of "Delrin" acetal plastic. The 24-page book describes and illustrates design factors, including strength and toughness; dimensional stability and resistance to solvents, fabricating and finishing of both molded and machined parts. Other topics include use of "Delrin" acetal in gears, bearings and electrical applications and a discussion of design latitudes. Tables of properties and test results and a summary table of properties according to standard ASTM tests are included. Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.

Patterned Aluminum Sheet Samples **454**

"Designed Surfaces", a publication for the designer and product engineer, shows 41 different forms of patterned aluminum sheet. A technical reference to the patterns cataloged, the brochure provides width and length availability data for alloys and tempers in which each pattern is normally available. Every pattern is reproduced full scale on textured heavy stock. Flexibility of patterned sheet as a design medium is discussed in terms of potential applications and the range of variations that may be chosen. Aluminum Co. of America, 1501 Alcoa Bld., Pittsburgh 19, Pa.

Plastic Tubings **455**

Details tubings and sleevings for electrical insulation in Class A through Class H temperature applications. The 12-page booklet describes extruded plastic types and tubings woven from glass filaments or other materials into the form of a sleeve and treated with an insulating coating. Intended as a reference aid in specifying tubings and sleevings for electrical-electronic applications, the brochure contains sections on how to pick the right tubing or sleeving, National Electrical Manufacturers Assn. grading, methods of applying tubing and sleeving insulation and useful storage tips. Selector charts illustrate the useful temperature ranges, electrical strength, chemical resistance at room temperature, resistance to cut-through and relative flexibility. Irvington Div., Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Circle 88 on Reader-Service Card

WHITEY

MICRO-REGULATING CORROSION RESISTANT LABORATORY FEED PUMP

THE PUMP THAT SELLS ITSELF

That a Whitey Pump sells itself is evidenced by the fact that customers who have purchased one invariably purchase another. The reason for this is simple. Unusual design features and extreme quality control assure trouble-free performance and qualify this pump for the most critical research and industrial service.

METAL DIAPHRAGM DESIGN

Hydraulically actuated diaphragm design provides zero leakage pumping. Fluids can never be contaminated by packings or seals and are completely contained by a metal to metal diaphragm seal.

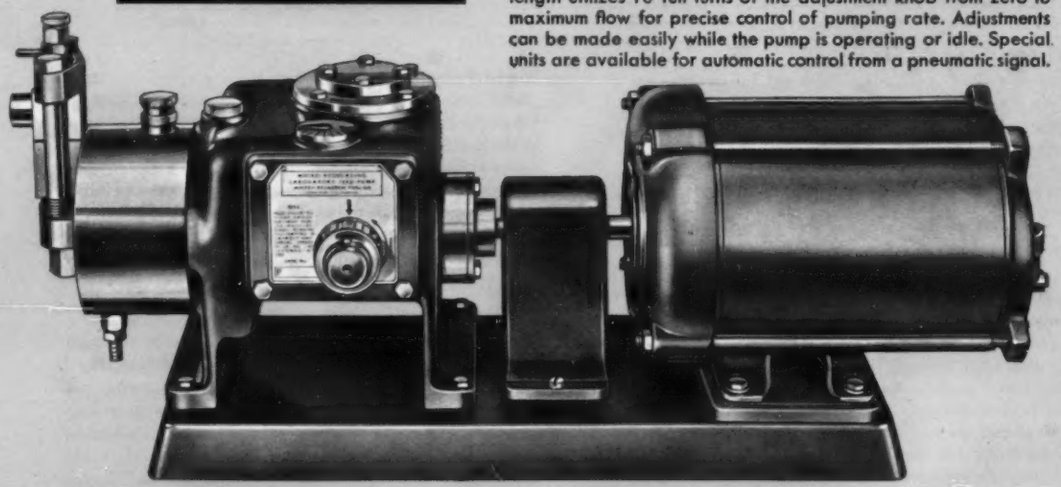
ACCURATE LOW FLOW RATES

The Whitey pump is available for maximum pumping capacity of 2½ gallons per hour. Six different plunger sizes, three standard gear ratios, and three motor speeds offer a flexibility in design to suit your exact requirements. Stroke adjustment permits low flow rates to less than 5 ml per hour.

CORROSION RESISTANT

Type 316 stainless steel is used for all wetted parts for maximum corrosion resistance. Monel, Inconel and Hastelloy are available for special applications. Explosion proof motors are standard equipment on all Whitey Micro-regulating Feed Pumps.

MICROMETER ADJUSTMENT: Micrometer adjustment of stroke length utilizes 10 full turns of the adjustment knob from zero to maximum flow for precise control of pumping rate. Adjustments can be made easily while the pump is operating or idle. Special units are available for automatic control from a pneumatic signal.



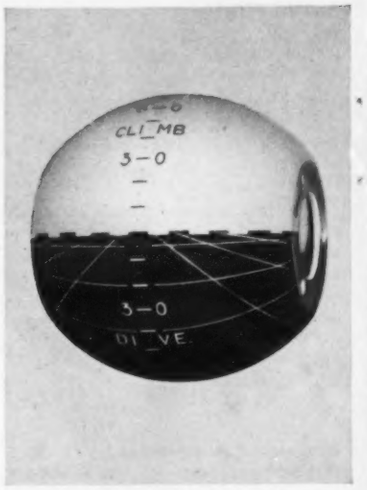
WHITEY FOR EXACTING SERVICE

RESEARCH TOOL CO. • 5525 MARSHALL STREET • OAKLAND 8, CALIFORNIA

G-E LEXAN® POLYCARB

STABLE ELECTRICALS. Binding posts made of LEXAN resin retain electricals even under moist, hot conditions. They do not loosen, are molded in six attractive LEXAN colors for coding. Other features are: low loss and power factor, low dielectric constant, high voltage insulation, non-sink surfaces. (Superior Electric)

HEAT RESISTANCE. Beautiful handles of LEXAN polycarbonate resin are used in rugged service on U.L. approved soldering irons. They resist the impact, heat and abrasion of daily bench work. The hard, glossy handles are light in weight. Molded in three pastel colors, they provide toughness and sales appeal. (Ungar Electric Tools)



DIMENSIONAL STABILITY. Maximum allowable change in this 5-inch aircraft instrument part is only 5 mils over a temperature range of —65° to 300°F! And it must maintain this tolerance under high humidity. Part is injection molded of LEXAN resin as half spheres which are solvent cemented, lathe-turned and painted. (Lear, Inc.)

Electrical Resins Selector 456

A revised guide to insulating resins and their uses for potting, encapsulating and coating electrical and electronic products, parts and assemblies. The chart provides reference to rigid and flexible epoxy potting resins, thixotropic dipping pastes and varnishes. Among new materials included are two liquid, flexible epoxy resins suitable for Class H operation, single-component 138 and two-component 143. Indicated for each resin in the listing are temperature class and thermal properties; physical and mechanical properties; pot life, type and proportion of hardener and curing method. The columnar layout in the tabulation facilitates comparison of viscosity, density, shrinkage, dielectric and impact strengths, conductivity and volume resistivity. The selector also summarizes each resin system's outstanding features, notes applications for which various resin groups are suitable and illustrates uses. Marblette Corp., 37-31 Thirtieth St., Long Island City 1, N. Y.

Metallized Ceramics 457

Discusses low- and high-temperature metallizing, design advantages and disadvantages and how to install or use. Bulletin 613, 16 pages, also describes electroplatings, dips or coatings available and proper selection. A chart of ceramic compositions most frequently used as metallized or ceramic-metal adjoinments is featured. Thermal-expansion-versus-temperature curves are shown and a table gives brazes and solders commonly used for assembly or installation of hermetic seals. Metals commonly used in ceramic-metal assemblies are listed. American Lava Corp., a subsidiary of Minnesota Mining & Mfg. Co., Chattanooga 5, Tenn.

Metal-Finishing Guide 458

This latest edition contains condensed information on materials and compounds for finishing operations, such as buffing, burring, polishing and satin finishing. The four-page guide provides a section on additives and specialties for bright plating processes for gold, silver, copper, nickel, cadmium, brass and zinc. The Lea Mfg. Co., 16 Cherry Ave., Waterbury 20, Conn.

Ultrahigh-Strength Steel 459

Describes "Vascojet M-A", a new structural steel offering tensile strength values to 360,000 psi and capable of maintaining high strength levels at operating temperatures to 1000F. Engineering data in the 20-page booklet include heat treatment, hardenability, hardness curves, thermal properties, mechanical properties, relation between hardness and tensile properties, fabrication, annealed properties, and curves and tables showing effect of tempering temperature on tensile properties. Vanadium-Alloys Steel Co., Latrobe, Pa.

Beryllium Copper Rod 460

Included in Bulletin R-1200-A are data on tensile strength, yield strength, elongation, Rockwell hardness and electrical conductivity of "Berylco" 10, 25 and 50 alloys. The eight-page brochure lists properties such as modulus of elasticity, coefficient of thermal expansion, density and endurance strength of the alloys. Tables are provided for the selection of the proper alloy. The Beryllium Corp., Reading, Pa.

Rigid Polyvinyl Chloride 461

A technical folder contains 23 pages of data on rigid polyvinyl chloride. Information given includes a description of the material and the products made from it, and physical and chemical properties. Design and fabrication data include machining, drilling, sawing, forming and bending as well as joining methods. The final section of the folder lists the many applications of the material. Kaykor Products Corp., Yardville, N.J.

Leather Packings 462

Available in a variety of sizes and shapes (including "U", cup, Vee, flange packings, gaskets and washers) leather packings for hydraulic pneumatic service are described completely in 12-page catalog, Form AD-186. Information provided includes complete tannage and impregnation information (including the new Moly S2), standard design dimensions, installation procedures, allowable clearances and ordering information. Garlock, Inc., Palmyra, N. Y.

Laminated and Fabricated Plastics 463

A 12-page brochure outlines the services and products the manufacturer offers in laminated, fabricated and molded laminated plastic fields. Illustrated are printed circuits, gears, bearings and machined military parts, as well as molded laminated parts, such as auto timing gears and aircraft control pulleys. The Richardson Co., 2634 Lake St., Melrose Park, Ill.

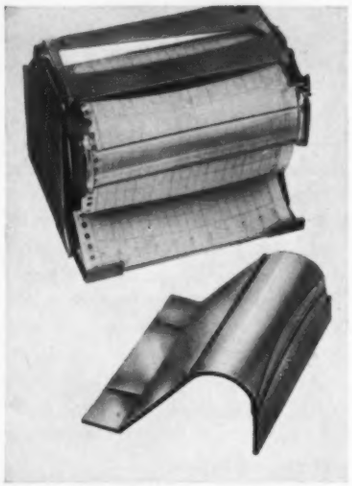
Plaster Mold Castings 464

An 18-page booklet describes precision casting with nonferrous alloys. Both plaster mold casting and planar investment casting are explained, as well as how both processes can be combined to overcome important limitations of either process alone. Photographs illustrate typical castings made by the different processes and an engineering table gives the specifications and properties of eight different nonferrous alloys. Atlantic Casting & Engineering Corp., 810 Bloomfield Ave., Clifton, N.J.

Silicone Rubber Electrical Insulation 465

Describes properties and handling characteristics of silicone rubber as they pertain to wire and cable insulation for use in aircraft and missile support equipment. Bulletin CDS-158, four pages, contains comparative data on radiation resistance and dielectric strength of silicone rubber compared to other materials and information on low-temperature flexibility, heat resistance, ozone and corona resistance of the material. General Electric Co., Silicone Products Dept., Waterford, N.Y.

ONATE RESIN GOOD DIELECTRIC— AND MUCH MORE!



TRANSPARENCY of LEXAN resin is important in chart guide for recorder. LEXAN resin is the only transparent plastic able to withstand heat generated by internal lights. It is distortion-free at temperatures up to 270°F and self-extinguishing. Its extremely high impact strength eliminates cracking of guides. (The Foxboro Co.)

TOUGHNESS. Press-fitted into metal gear used in an electric drill, bushing of LEXAN polycarbonate resin provides safety from electric shock . . . helps eliminate need for additional grounding. Strength and creep resistance of LEXAN resin enables bushing to withstand torque and load requirements of drill. (Millers Falls Co.)

ARE YOU LOOKING FOR A PLASTIC THAT CAN REALLY TAKE IT?

To demonstrate the toughness of LEXAN resin, salesmen will sometimes slam and hammer a product made of the material. LEXAN has the highest impact strength of any plastic – amounting to 12-16 foot-pounds per inch of notch – and it usually emerges unscathed from encounters with such "merchandising stresses". It is a high-performance material, likewise, with regard to high-temperature behavior and dimensional stability.

Its many other advantages make it a priority material for thorough investigation by all designers, engineers and molders. We will be pleased to supply you with information on the properties, processing and end-uses of LEXAN resin. Don't hesitate to write to us. General Electric, Chemical Materials Department, Section DN-11, Pittsfield, Mass.

LEXAN®
Polycarbonate Resin
GENERAL ELECTRIC

Circle 89 on Reader-Service Card for more information

Flat Plastic Optics **466**
Catalog 6104-10T describes "Frenelens" flat optics – lightweight, thin and flat sheets of transparent plastic and "Frenelens" cellular optics – special lenses which differ from continuous-surface-type lenses in that their surfaces consist of a number of stepped zones. Applications described include many types of field-lens applications such as table viewers for photo transparencies, microfilm projectors, optical comparators, reflex cameras and photomicrographic equipment, and in microfilm or other rear projection devices such as optical comparators. The eight-page catalog gives characteristics of the plastic optics. Bolsey Research & Development Div., Bolsey Corp. of America, 11 West 57th, New York, N.Y.

Acid Gold-Alloy Plating Solution Analysis **467**
Quick, accurate analysis of acid gold-alloy plating solutions obtained by polarographic methods are detailed in a three-page paper. A reprint of a paper originally presented to the American Electroplating Society, this material is a handy reference for electroplaters who must meet or exceed exacting government and industrial specifications requiring precise control of acid gold-alloy electroplate. The development of a polarographic method for testing and evaluating acid gold-alloy electrodeposits is described, and graphs, formulas and specific examples illustrate the text. A table compares results of polarographic and standard analytical methods and lists notes for further reference. Sel-Rex Corp., Nutley 10, N.J.

High Permeability Magnetic Metals **468**
This 40-page brochure contains new material on permeability and core loss of high permeability "49" and HyMu "80" alloys at both 60 and 400 cycles. Punched for standard 8-1/2- by 11-inch loose-leaf binding, the booklet is prefaced by a section on the selection and use of test methods; magnetic behavior of metals and various alloys tested. Tables, graphs and charts illustrate the data provided. Magnetic Metals Co., Hayes Ave. at 21st St., Camden, N.J.

Foam Products Charts **469**
These two charts show the properties and uses of a variety of standard foam products. For the first time a tabulation of dielectric and physical properties of artificial and adjusted dielectric constant foams also is included. Foam sheets (both rigid and flexible), as well as a number of foam-in-place and pack-in-place foams, are described. Illustrative photos of the materials are provided. Emerson & Cuming, Inc., Canton, Mass.

Urethane Seals and Packings **470**
The various types, sizes, operating features and advantages of a complete line of solid urethane hydraulic seals and packings are detailed in an eight-page catalog. Advantages of an especially designed chamfered sealing lip are cited. Three pages of tables show range of sizes and types of seals and packings available. Disogrin Industries, Div. of Pellon Corp., 510 S. Fulton Ave., Mt. Vernon, N. Y.

Pour-in-Place Urethanes **471**
Illustrates the versatility and varied uses of "Nopcofoam" pour-in-place urethanes. The 12-page publication contains illustrations of actual uses and describes typical applications as low-temperature insulation, building structures, potting, cushioning and packaging. The booklet stresses the fact that the gas-expanded, poured-in-place urethane foams are low in cost and easy to handle while offering properties of toughness, strength, lightness, sound absorption, shock absorption, water resistance, thermal insulation and electrical insulation. Nopco Chemical Co., 175 Schuyler Ave., North Arlington, N. J.

Silicone Rubber **472**
A collection of excerpts from a forthcoming book entitled "Silicone Rubber", written by Stanley Kogut. This 60-page handbook, "The Uses and Abuses of Silicone Rubber", covers processing, source of supply, classifications of silicone rubber, properties of general-purpose silicones, use of silicones in fluids, hybrids, weather resistance, heat resistance, low-temperature flexibility, dielectric properties and testing of silicone rubber. A summary of specifications for silicone rubber and a properties chart complete the manual. Mechanical Rubber Products Co., Warwick, N. Y.

Designing with Phenolics **473**
Guidelines for designing with phenolic molding compounds are found in a fold-out form entitled "7 Questions and Answers About Designing with Phenolics". Questions include: "Are phenolics engineering materials?", "Do phenolics have design properties you need?", "What are key design considerations of phenolics?" and "What are some examples of excellent design in phenolics?". Form CDC-394 also lists typical applications and design properties of the materials and compares their costs with those of metals. General Electric Co., Chemical Materials Dept., Pittsfield, Mass

Ceramic Capacitors **474**
Bulletin 516 describes the results of more than 17 years of research, engineering and reliability studies of ceramic capacitors. The 10-page bulletin details capacitors with failure rates as low as 0.001 percent failure per 1000 hr of testing at rated conditions. Bulletin 500-1, 10 pages, describes "Gold-Seal Button-Mica" capacitors with high (200C) operating temperature range, good conductivity and high leakage resistance. A new flag-type terminal available in both stand-off and feed-through types is featured. Erie Resistor Corp., 644 W. 12th St., Erie, Pa.

Nickel-Alloy Coating **475**
Describes the "Kanigen" process for depositing a uniform, hard, corrosion- and abrasion-resistant nickel-alloy coating on iron, copper, aluminum, titanium and their alloys without the use of electricity. The 12-page brochure gives the chemical analysis, specific gravity, melting point, electrical resistivity, coefficient of expansion, thermal conductivity, hardness and ductility, frictional properties, abrasion resistance, porosity, salt spray resistance and adhesion characteristics of the coating. Corrosion studies of the chemical nickel-alloy plating are shown in table form. Kanigen Div., General American Transportation Corp., 135 S. LaSalle St., Chicago 90, Ill.

An Introduction to Designing with Plastics

R. L. Thorkildsen and J. V. Schmitz, General Electric Co.

Today's design engineer has two big advantages in being modern. First is a high level of knowledge. He has available a broad theoretical background and much practical knowledge gained in a competitive industrial world. He also has a wide variety of versatile new materials. Today's designs would be costly and impractical with yesterday's materials. A most challenging and useful class of new materials in the "Materials Age" is the family of organic polymers called plastics. Like other new materials, plastics provide tremendous design opportunities but also pose special design problems.

The rapid growth of plastics use has not been easy. Amid the successes, a great many mistakes in applications and in design have been made. Many more can be expected. Plastics differ considerably from other common structural materials in their mechanical behavior and the successful application of plastics requires re-education of all of us in new concepts of design. Plastic materials obey technical and physical laws that can be discovered, described and used, and intelligent designing with plastics can be learned. Some guiding rules already are understood and more are being discovered with each new plastic application. Discovery of these important underlying principles requires joint effort by all of us—engineers, mechanists, physicists and chemists.

Property Advantages of Plastics

The chief general advantage of plastics, and derivation of the name "plastic", is in processing. Plastic articles can be formed readily in unusual shapes, such as films, fibers, foams, reinforced laminates or complicated molded or extruded configurations. A clever designer can take advantage of this form versatility and replace a complex assemblage with a single molded part. The processing is often adaptable to rapid mechanized production methods with relatively low costs for tools, equipment and overhead. Raw-material price trends promise further economy. The material costs are decreasing while most other materials are becoming more expensive.

Can plastic materials fit design needs? There are over 30 general classes of plastic materials. The thousands of individual chemical compositions within those classes display a very broad range of useful properties. Most plastics have low electrical conductivity, low thermal conductivity and low specific gravity. Color, transparency and appearance are particularly important advantages of some classes, such as acrylic, cellulosic or urea-formaldehyde plastics. Some plastics are available with low coefficient of friction and others have nonslippery surfaces. Various plastic materials, such as polyolefins, offer good resistance to water and to many other chemicals. In addition, many plastics show unusually good toughness and resilience.

Property Limitations of Plastics

Plastics have limitations in mechanical, thermal and chemical properties. These often can be overcome by intelligent design or choice of material but they must be recognized clearly. The generally low strength of many plastics is sometimes a problem; higher strength plastics are available but usually at the expense of processing ease, toughness or material costs. A systems concept using combinations of metals and plastics also can give the needed strength as it does, in another field, in reinforced concrete.

Plastic materials are basically organic polymer molecules held together by relatively weak forces.

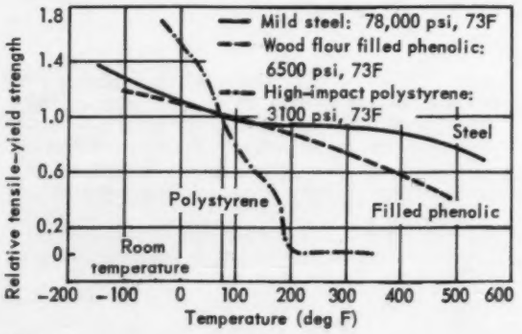


Fig. 1

EFFECT OF TEMPERATURE on tensile yield strength of mild steel (0.10 percent carbon), wood flour filled phenolic resin and high-impact polystyrene. Relative tensile yield values shown are related to strengths at 73F.

This shows up in changes of mechanical properties because of processing, chemical environment, temperature and rate of load application.

Processing effects are familiar problems in work with any material. Plastic molding can influence properties resulting from orientation from flow, differential shrinkage and thermal stresses. As with wood, anisotropy in plastics can be used to advantage. This is the source of extra strength in many synthetic textile fibers and in the oriented glass-fiber-reinforced plastics used in fishing rods or military missiles.

The chemical structure of the plastic has a great influence on its chemical properties. In general, plastics are more resistant to water systems than metals but more sensitive to organic solvents. However, some plastic materials, as the fluorocarbons, have remarkably good resistance to almost all chemicals.

Time and Temperature Effects

The profound influences of temperature and of time (rate of load application) on properties of plastics are more difficult to appreciate.

The useful temperature ranges of plastics differ among various classes but are generally much more narrow than with metals. Fig. 1 compares the influence of temperature on tensile strength of a common thermoplastic (a polystyrene) and a common thermosetting plastic (a phenolic). The behavior of steel is included for comparison. Tensile-strength values are quoted as percentage of strength at 73F.

Time, as in the rate of load application or duration of load application, influences the strength of all plastic materials. This time-dependency is a direct result of movement of the loosely held organic high polymers in all plastics. Creep occurs under constant load; stress relaxation occurs under constant strain. Catastrophic failure can occur at low loadings under either fatigue (alternating stress), creep (steady stress) or shock loading (impact) conditions. Some typical data, in Fig. 2, compare the time-dependency of rupture strengths of a thermoplastic, a thermosetting plastic and steel over a wide range of strain rates.

Time-dependent strength also shows strong interactions with temperature or with chemical environments.

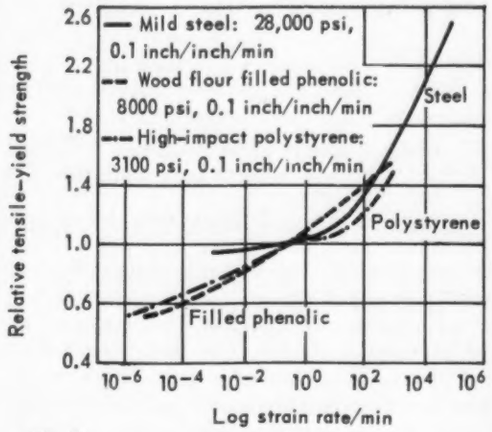


Fig. 2

EFFECT OF TENSILE STRAIN RATE on tensile yield strength of mild steel (0.1 percent), wood flour filled phenolic resin and high-impact polystyrene at 73F.

General Concepts Of Evaluating Plastic Designs

Before he plunges into a design and material choice it is necessary for the engineer to define his reasons for considering plastics.

The most valid method for evaluating the final combination of design and materials choices is in actual use under the conditions of the application. This type of testing is usually expensive and, therefore, can seldom be used as a screening test. An occasional application, such as in packaging or film, might allow thorough end-use testing. Most applications, however, involve expensive molds or complete assemblies or would require too much time to test only under actual use conditions.

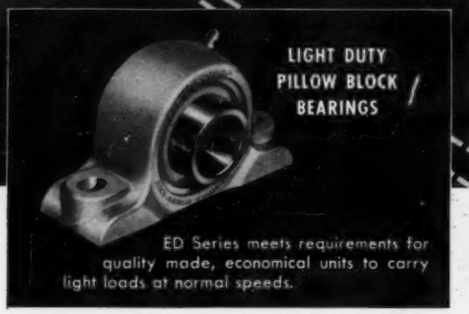
A second type of evaluation, accelerated testing of either complete assemblies or design prototypes, is less reliable than end-use testing but much more practicable for proving out engineering choices. Testing of prototype samples often suffers from a further decrease of reliability but allows more tests to be run at still lower cost.

It is seldom possible to rely solely on intuition and engineering tests to choose the best plastic material for an application. In most cases, at least a preliminary screening method is needed to limit the choice of material and process to a workable number of possibilities. Preliminary screening data are available from a wide variety of fairly simple and relatively inexpensive laboratory tests. Laboratory evaluation tests make possible testing of a large number of materials under many combinations of conditions. Many of those tests have been developed through work of the American Society for Testing Materials.

Coordinating the Work Of Several Disciplines

There are few cases where reliable designing can be done solely on the basis of information furnished

(Continued on next page)



ED Series meets requirements for quality made, economical units to carry light loads at normal speeds.

WITH *hoover-honed* RACEWAYS... *micro-velvet* BALLS

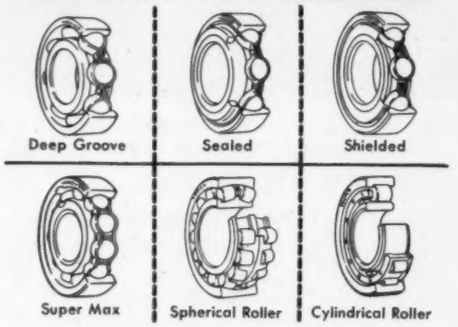
Hoover SP and SPH series pillow block bearings are designed for quick, easy installation. They are automatically self-aligning in any direction. The eccentric collar forms a self-tightening shaft lock. Elongated bolt holes in the base of the pillow block simplify mounting.

Hoover Quality bearing features assure long life and superior performance. *Hoover-Honed* raceways are super smooth, superbly finished. *Micro-Velvet* balls are accurate within millionths of an inch. Felt seals with metal shields retain factory applied lube and protect working surfaces from dirt.

Recommended for normal duty load conditions and shock, Hoover SP and SPH series pillow block bearings are available in shaft sizes from ¾" to 2 15/16".

Hoover-Honed and *Micro-Velvet* are Hoover Trademarks

HOOVER PRODUCES A COMPLETE LINE OF BALL AND ROLLER BEARINGS IN TYPES AND SIZES FOR MOST APPLICATIONS



hoover
BALL AND BEARING COMPANY
5400 South State Road, Ann Arbor, Michigan
Zone Sales Offices and Warehouses
8581 South Chicago, Chicago 17, Illinois
290 Lodi Street, Hackensack, New Jersey
2020 South Figueroa, Los Angeles 7, California

Hoover Ball and Bearing Company DN-9
5400 South State Road, Ann Arbor, Michigan
Please send Bulletin 106 which describes Pillow Block Bearings.
Name
Title
Company
Address
City Zone State

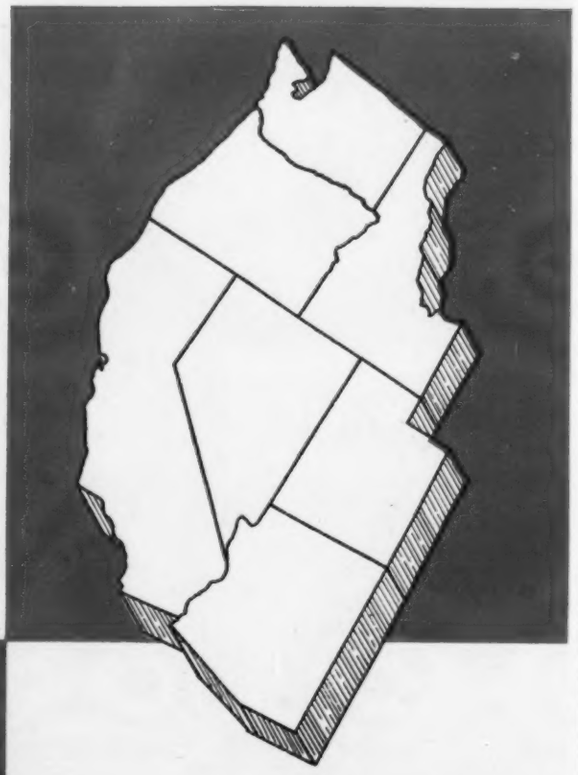
Circle 90 on Reader-Service Card for more information

Ed Schrader

(B.S. — M.E., University of California)

covers

- California
- Oregon
- Washington
- Idaho
- Nevada
- Utah
- Arizona



for Design News

Before digging out story details, Schrader gathers important background information.

Ed insists on getting information for his articles first-hand... all Design News Regional Editors do!

Ed is always on the move in search of new Design Ideas. It's his job to find them, to select pertinent facts, drawings and background material... and then to report them accurately and concisely to you, the Design News Reader.

Of course, many of his leads come by phone or letter from men like yourself. These he follows up in person.

Do **you** have an interesting Design Idea now past the preliminary design stage? If so, contact **Edward W. Schrader, Western Editor, Design News, 6399 Wilshire Blvd., Los Angeles 48, Calif., OLive 3-9720.** He'll be glad to discuss a possible article with you.

Engineer-editor Schrader gets the heart of Design Idea with men who made the news.

by material suppliers, even when supplemented by engineering tests. This approach is safe only with very simple designs where failure is unlikely or inexpensive.

We have found in our work that there is available a better approach for safe designing with plastics. This is coordinated work by a "plastics applications team". The team usually consists of a design engineer, manufacturing engineer, materials engineer and laboratory evaluation specialist. This team can cover the full range of problems from initial design ideas and material choice through evaluation and process development to final production and quality control. During the course of this program realistic specifications and test methods are established for material, process and finished part.

An example of the work of a plastics application team is a recent design program for refrigerator-door liners. For evaluation of design and materials for door liners it was necessary to translate the actual use conditions into terms of stress, time and temperature. This can be visualized on three-dimensional curves of stress-strain-strain rate, Fig. 3.

Recommendations for Future Work

It is necessary to develop methods which can be used to predict materials and structural performance using a limited number of simple tests and mathematical tools.

This is the meaning of materials—and structural analysis. It must be recognized that analysis is not in itself a guarantee of success in design. Materials and structural analysis must be accompanied by imaginative and creative thinking and by experimentation in potential new product lines.

Abstracted from technical paper ASME No. 61-MD-18; The American Society of Mechanical Engineers, 29 W. 39th St.; New York 18, N.Y.

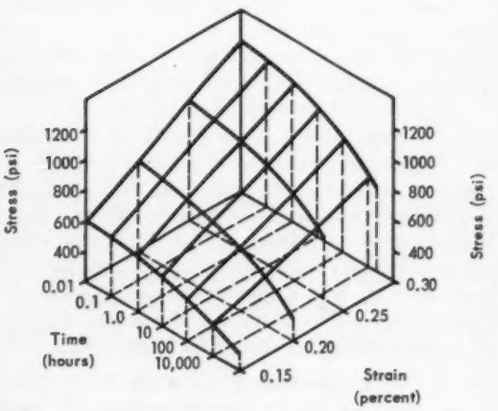


Fig. 3
TENSILE STRESS-STRAIN-TIME RELATIONSHIPS of a high-impact polystyrene at 73F.

Silicone Rubber as Thermal Coatings For Missiles and Space Vehicles

M. E. Groby, General Electric Co., Waterford, N. Y.

Silicones are making an ever-increasing contribution to the successful operation and reliability of missiles, rockets and space vehicles. Silicones' superior resistance to heat and cold, stable electrical properties, unequaled resistance to long-term aging and weathering, high degree of water repellency, good radiation resistance and outstanding thermal insulating properties provide the margin of safety that often means the difference between complete functional reliability and erratic operation or failure.

Silicones are produced in several forms – fluids, resins, rubbers and greases – and all find use in missiles and space vehicles. The product area offering the greatest potential is that of silicone rubber, elastomeric member of the silicone family.

Silicone rubber is available in two basic forms – one form being the heat-curable stocks used for fabricating parts and as insulation on wire and cable; in the other form as RTV's, or room-temperature vulcanizing materials.

The heat-curable stocks are cured with the addition of a peroxide curing agent on a rubber mill – molding it to the desired configuration in a hot mold and post curing in an oven. The RTV's are pourable liquids or thixotropic pastes which are cured at room temperature by the addition of a metallic soap. Some typical heat-cured silicone-rubber applications are hatch or probe hole seals in missile instrumentation sections, nose-cone forming blankets, vibration or shock mounts, silo door seals and gaskets.

RTV silicone rubber is used on almost every type of missile. The RTV's are used as sealants, potting, encapsulants, rubber cushions, and as thermal insulating and ablation materials.

To obtain reliable data on the effect heat of ablation, ablation rate and weight losses under relatively low enthalpy and pressures, the electric air arc supersonic tunnel was used at General Electric's Missile and Space Vehicle Dept. in Philadelphia.

The most significant, outstanding thermal characteristics of the silicone rubbers are their effective heat of ablation and rate of ablation.

Abstracted from a technical paper presented before the 47th Mid-Year Meeting of the Chemical Specialties Manufacturers Assoc., Chicago, Ill., May 15-17, 1961. Chemical Specialties Manufacturers Assn., Inc., 50 E. 41st St., New York 17, N.Y.

which of these quality PPG fiber glass reinforcements fits your operations?

533 Roving . . . for filament winding, panels, rod stock

. . . highly effective wet-out with polyesters, phenolics and epoxies in producing translucent products with high unidirectional strength.

520 Roving . . . for spray-up applications

. . . provides close control in uniformity, cuts clean, dispenses freely, wets well, has color trace strand.

508 Roving . . . for preform molding

. . . drapes well, distributes evenly, conforms well, runs free of static, has high strength, cuts rejects to a minimum.

Chopped Strand Mat . . . for sheets, boats, high pressure molding

. . . wets out faster than ordinary mat, has uniform fiber distribution; provides improved strength, appearance and workability; pure whiteness eliminates discoloration.

TECHNICAL HELP AVAILABLE

Samples of these quality reinforcements are available for trials in your own plant. A PPG technical staff man will be glad to answer any questions you may have and demonstrate techniques and machinery adjustments to get best production results.

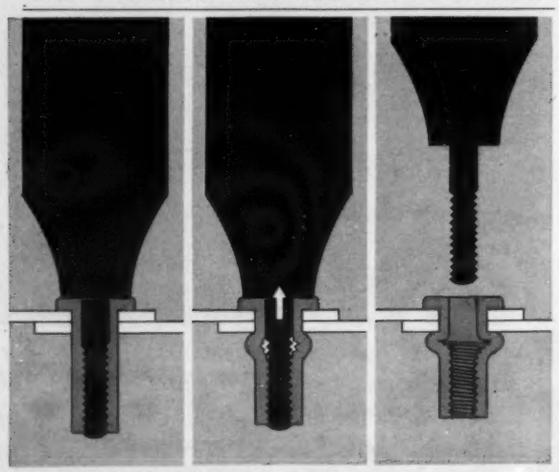
For literature and other information, get in touch with your nearest PPG Fiber Glass Sales Office or regional distributor, or write *Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Pa.*

FIBER PPG GLASS PITTSBURGH PLATE GLASS COMPANY

Sales Offices: Atlanta, Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Houston, Kansas City, Louisville, Los Angeles, Miami, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis and Seattle

Circle 92 on Reader-Service Card for more information

Circle 93 on Reader-Service Card for more information



RIVNUTS® provide sturdy nutplates in seconds...cut assembly time and cost

Simply drill a hole, insert RIVNUTS® on heading tool, upset and withdraw tool. RIVNUTS® provide several internal threads for screw fastening. It's all done from the exterior of the work. For RIVNUT Data Book write *Dept. DN-9B, B.F.Goodrich Aerospace and Defense Products, a division of The B.F.Goodrich Company, Akron, Ohio. In Canada: Kitchener, Ontario.*

B.F.Goodrich Rivnuts

Circle 94 on Reader-Service Card for more information

Air Nozzles on Floating Beam Increase Accuracy

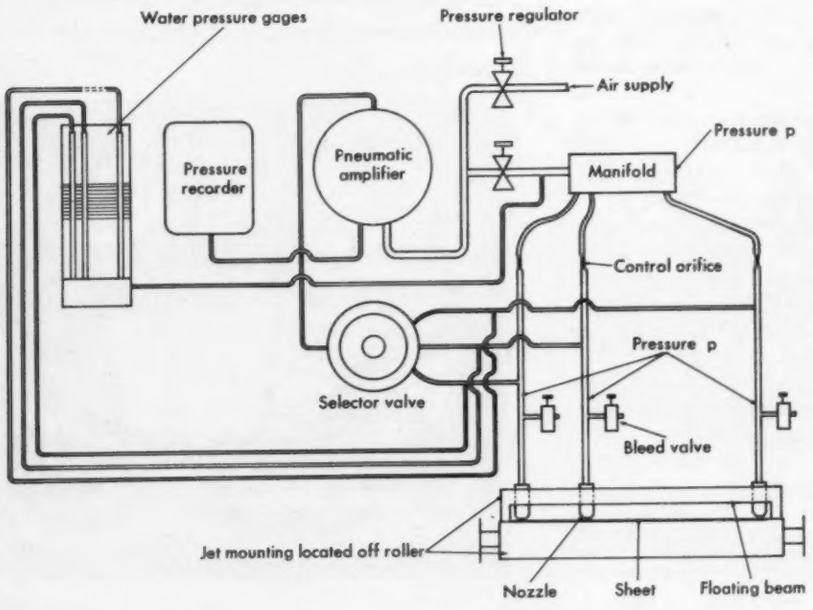
Ronald W. E. Martin, British Editor

A pneumatic machine continuously measures thin, soft sheet material. Air gaging nozzles are carried by a floating beam which rides on the datum roller over which the sheet passes. Any eccentricity in rotation of the roller, as it is turned by the sheet, is imparted simultaneously and equally to the air nozzles and the sheet. Design maintains measuring nozzles at a fixed distance from the roller surface and permits a measuring accuracy better than 0.00002 inch.

Work to be measured passes over the freely rotatable datum roller and under a line of equally spaced nozzles. The nozzles are fed with air through a constriction from a manifold maintained at a constant pressure P (2 psi above ambient atmospheric pressure). The pressure P between the constriction and the nozzle is measured by water gages. The gages have a common airtight reservoir, pressure in which is also kept at value P by connection to the manifold. Air escapement at the nozzle depends on sheet thickness. Proportionality to 1 percent between thickness and pressure p is achieved provided that $\frac{p}{P}$ lies within the range 0.6 to 0.8. An increase in thickness leads to an increase in p and, therefore, to a depression of the water level. Thickness measurements are indicated simultaneously and continuously by the water pressure gages, one for each jet, and the liquid levels show thickness profile across the sheet.

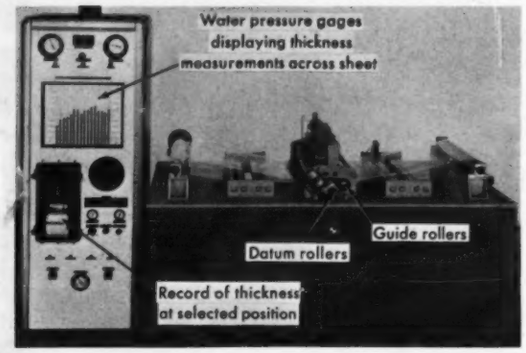
The inverted Y-section beam carrying the nozzles is located on the datum roller by four bearing pads, two at each end. The jets lie in a plane passing through the axis of the roller. Effective weight of the beam assembly is minimized by a simple counter weight arrangement. Friction at the bearing pads is minimized by the use of sintered bronze plates impregnated with plastic. Each plate is backed by a machined and lapped steel block which is fastened to it by an epoxy resin. A precision spacer, mounted between the block and the lapped undersurface on the beam, is used for adjusting the nozzles' position.

The pneumatic measuring machine was designed by Britain's National Physical Laboratory, Teddington, England, for continuous measurement during production of soft material such as cellulose sheet.

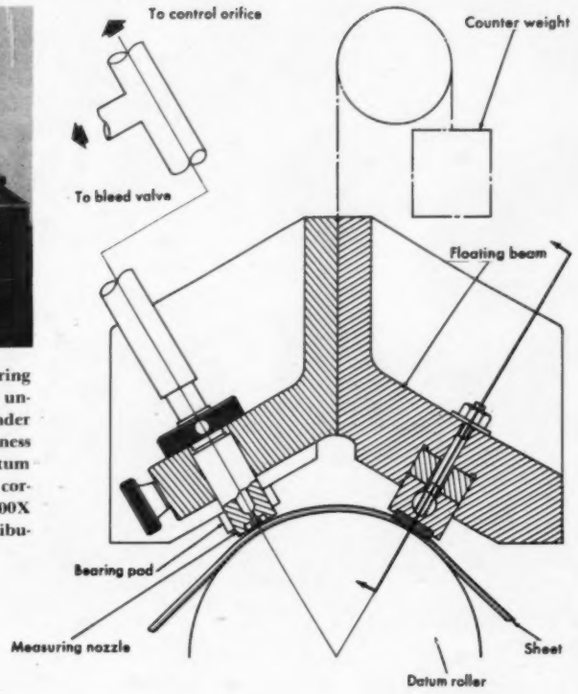


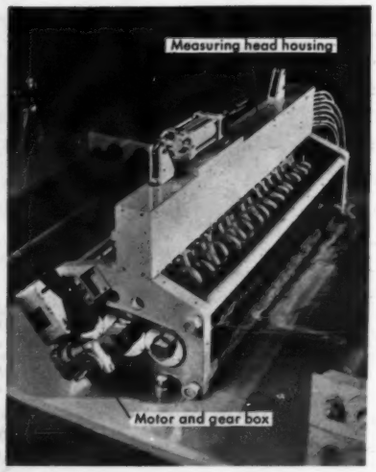
PNEUMATIC CIRCUIT of gaging machine. For recording thickness at any point, pressure p is fed to pneumatic amplifier which provides output in range 2 to 14 psi proportional to changes in p. This output operates pressure recorder giving overall magnification of 3500. Thus, change in sheet thickness of 0.0001 inch displaces pen by 0.35 inch. Selector switch connects amplifier to any measuring nozzle across sheet.

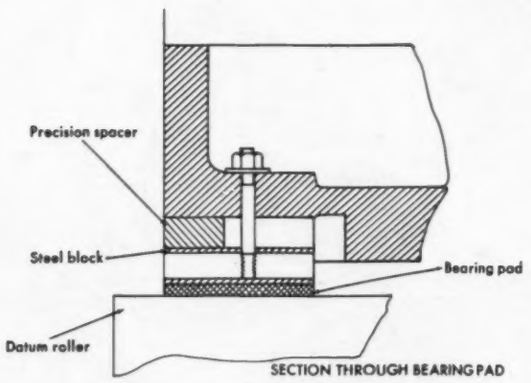
# of Pneumatic Gaging Machine


Water pressure gages displaying thickness measurements across sheet
Guide rollers
Datum rollers
Record of thickness at selected position

PNEUMATIC GAGING MACHINE set up for measuring continuous loop of cellulose acetate sheet. Material passes under forward guide roller, over datum roller and then under rear guide roller. Water pressure gages display thickness measurements across sheet. When sheet is in place on datum roller, gage readings are unaltered if sheet thickness is correct. Departures from nominal value are shown at 12,500X magnification by changes in water level and indicate distribution of thickness across sheet.







SECTION THROUGH BEARING PAD

MEASURING NOZZLES are mounted in balanced beam which rides on datum roller. Any eccentricity in roller, as it is turned by sheet, is imparted to sheet and nozzles. Each jet is adjusted so that air pressure indicated on manometer is at center point of linear working range. Final position of water level is set by bleed valve. Initial jet adjustment is made with roller rotating slowly to smooth out residual errors resulting from small imperfections in roller (motor and gearbox unit rotate roller for this purpose only). On completion of preliminary adjustment, measuring head is prepared for measuring sheet by increasing distance of nozzles from roller by an amount equal to nominal sheet thickness. Separation is achieved by changing precision spacers in locating pad assemblies. Spacers have an accuracy of ± 3 microinches. Their use avoids complicated manufacturing of accurate standards with same nominal thickness as sheet.

WE FABRICATE IN MORE THAN

200

DIFFERENT MATERIALS!*

GASKETS PACKINGS WASHERS
SEALS SHIMS BUSHINGS "O" RINGS

If it's a problem of the right material for the job—at the right price—Auburn is sure to have the perfect solution among the wide range of materials in which we work.

Put our 87 years experience to work for you—Auburn's engineers are tops in their field in designing and fabricating precision sealing devices. Their know-how is at your command. "O" Rings are a speciality with us.

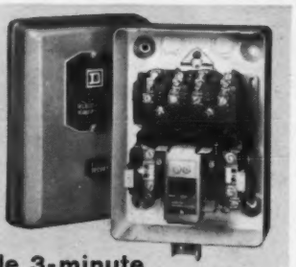
* Leather · Asbestos · Nylon · Vinyl · Teflon · Silicone Rubber · Neoprene · Rubber Cork · Fibre · Compositions · Phenolics · Cloth · Felt · Paper · Cardboard · Plastics Brass · Steel · Copper · Aluminum · Kel-F · Other Special Materials

THE AUBURN MANUFACTURING CO.
328 Stack St., Middletown, Conn.

Circle 95 on Reader-Service Card for more information

ONLY SQUARE D STARTERS WITH ONE-PIECE OVERLOAD RELAYS GIVE ABSOLUTE PROTECTION!

Write for the complete story on Square D Starters...



Plus this simple 3-minute "JIG-SAW" demonstrator

Write Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin

SQUARE D COMPANY
wherever electricity is distributed and controlled

Circle 96 on Reader-Service Card for more information

PRECISION-MADE SOLDERLESS TERMINALS

Immediate delivery on any type, any size . . . designed to fit most types of crimping tools

The progressive die-stamping pictured above is just one of the up-to-date production techniques that insure the high quality of Hollingsworth terminals. Fashioned from pure copper of the highest grade, all Hollingsworth terminals are meticulously manufactured to provide a completely reliable, vibration-proof connection.

Hollingsworth manufactures 16 types of solderless terminals as standard. They also custom-design solderless terminals for special applications. Whether your terminal requirements are ordinary or extraordinary, Hollingsworth can fill them to your complete satisfaction.

- Full ¼" working shank
- Lead capacity greater than that of the wire
- V-type grooves in throat grip wire securely
- Insulated types are color-coded according to size
- Beveled mouth for fast, easy wire insertion

Write for Hollingsworth catalog

HOLLINGSWORTH

COMPANY

Solderless Terminal Division

PHOENIXVILLE, PENNSYLVANIA

SA 2120

Circle 97 on Reader-Service Card for more information

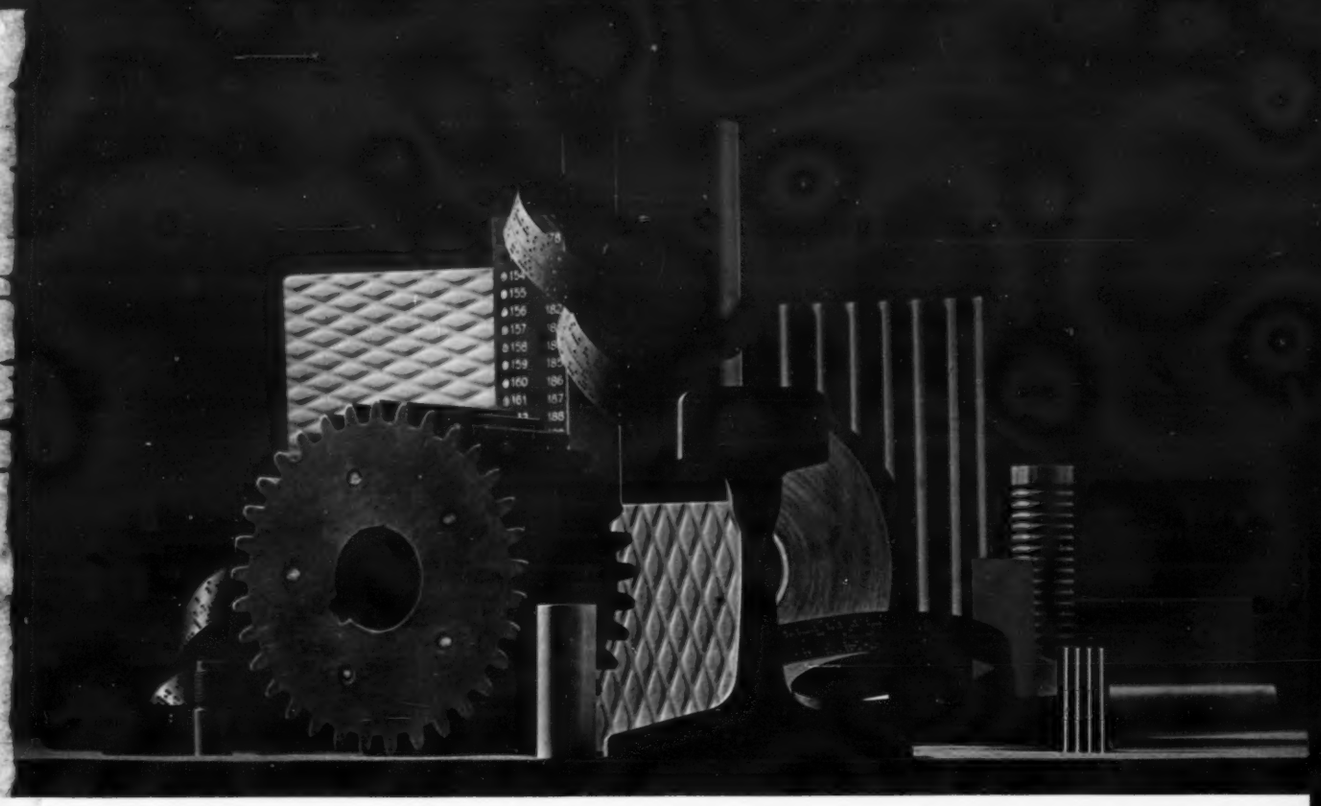
NEW BOOKS

HANDBOOK OF THERMO-PHYSICAL PROPERTIES OF SOLID MATERIALS. (4300 pages). A monumental five-volume work of reference, compiled and prepared by the Armour Research Foundation for the use of government contractors in the missile, aircraft and nuclear science fields, represents more than 17 years of research. This handbook (in the true sense of the word) is printed on heavy paper, hard bound and covered with sturdy buckram for durability in laboratory, office or library. All published data on 12 vitally important physical properties are brought together here in conveniently arranged, permanent form. Five properties of the twelve covered—Density, Melting Point, Latent Heat of Fusion, Latent Heat of Vaporization, Latent Heat of Sublimation—are grouped together for convenience on a single data sheet. Materials include elements melting above 1000F (Volume 1), alloys (Volume 2), ceramics (Volume 3), cermets, intermetallics, polymetric materials and composite materials (Volume 4). Each of the first four volumes contains explanatory text, the materials index and tables of conversion factors to facilitate use of the data sheets and graphs. The fifth volume is a reference guide, listing sources of every item of data found in the handbook. This U. S. Air Force authorized edition contains material collected, evaluated and compiled by Alexander Goldsmith, Thomas E. Watterman and Harry J. Hirschhorn and the staff of Armour Research Foundation, Illinois Institute of Technology. MacMillan Co., Riverside Burlington County, N.J.; $90.

ASM REVIEW OF METAL LITERATURE, 1960, contains 11,903 annotations of articles, technical papers, reports and documents appearing in engineering, scientific and industrial journals and books throughout the world during 1960. Prepared at the Center for Documentation and Communication Research, Western Reserve University, Cleveland, Ohio, the book is divided into 20 sections covering many areas of materials and process engineering and technology. Included in these major fields are general metallurgy, ore and raw material preparation, powder metallurgy, assembling and joining, metal products and parts, mechanical properties and tests, corrosion and instrumentation. A collation of the monthly publication "ASM Review of Metal Literature", the material in this volume was prepared by technical abstractors and translators. The annotations are brief indicative abstracts giving scope and content of the articles to help the reader determine whether he wants to read them in their entirety. In using the book, the reader can turn immediately to the section concerning the general field in which his primary interest lies. A complete author index is provided as well as a list of addresses of journals and periodicals from which the literature references are taken. Published by American Society for Metals, Metals Park, Novelty, Ohio; 1342 pages; $25.

PLASTIC TOOLING—a completely revised second edition. The various aspects of a plastic tooling program include material properties and fabrication methods. Many new materials and techniques have been added such as metal fiber-reinforced epoxies and even developmental processes such as gas or electroless nickel-plated surfaces for plastic tools. Malcom W. Riley also details the usefulness of each technique. The author has included a discussion on resin chemistry which should enable the engineer to work with plastic materials and with suppliers on a sound basis. Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y.; 216 pages; $7.50.

Circle 98 on Reader-Service Card



THIS remarkable plastic may trigger a new (or cost-saving) design idea for you

National Vulcanized Fibre is unique. It's a tough, cellulosic plastic—not mere paper or fiberboard. Vulcanized Fibre possesses an unusual combination of mechanical, electrical and thermal properties. For example . . .

It weighs one-half as much as aluminum, yet is one of the strongest materials known per unit of weight. It's tough, durable and cushions the shock of repeated blows.

Vulcanized Fibre has superior arc-resistance. It comes in standard and special grades, including a fire-resistant grade called "Pyronil." It can be machined, formed or deep-drawn into intricate shapes, and can be combined with other materials . . . aluminum, rubber, "Mylar," copper, laminated plastic, plywood, to name a few.

You can polish it, paint it, lacquer it, emboss it. And regardless of the finish, it resists oils, gasoline, fungi, most solvents. Most surprising is its low cost.

Find out for yourself why National Vulcanized Fibre is "the plastic with a million uses." There's a free sample kit waiting for you at a nearby NVF sales office. Check Sweet's Product Design File 2b/Na for the one nearest you. Or write directly to Dept. RR, Wilmington, Delaware.

116 Choices: One Source This is the latest count of the different plastics and grades NVF can offer in your search for the *one best material*. Add to this total *the* one special grade that can be developed from scratch to meet your particular need. This full range of materials is backed by complete engineering services . . . from application assistance up to and including the delivery of 100% usable, precision-fabricated parts . . . in any quantity, on time!

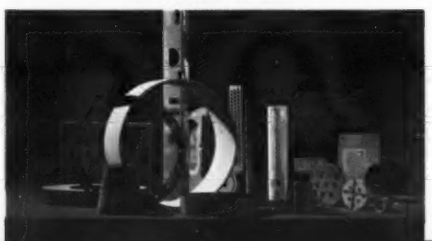
Call the NVF Sales Office near you. It's a direct line to single-source help on your current materials problem.

NVF

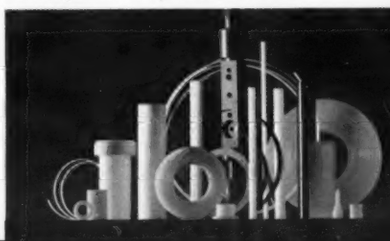
NATIONAL VULCANIZED FIBRE COMPANY
WILMINGTON 99, DELAWARE
In Canada: NATIONAL FIBRE COMPANY OF CANADA, LTD., Toronto 3, Ontario

5 grades of polyester

85 Phenolite® laminates



3 thermoplastics . . . nylon, Delrin®, Penton®



Falcon missiles travel "first class" in containers secured by LINK-LOCK

Fourteen No. 2 LINK-LOCK fasteners → maintain a pressure-tight seal around cover of Falcon cases.

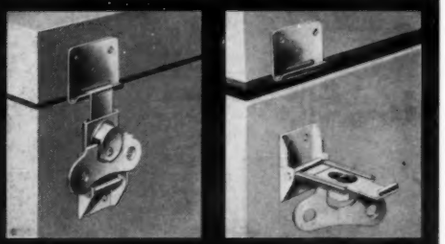
Before they take to the skies, Falcon air-to-air guided missiles are shipped or stored in containers sealed pressure-tight by Simmons LINK-LOCK fasteners.

These precisely engineered fabricated aluminum cases are produced to Hughes Aircraft Company specifications by the following companies: Vendorlator Manufacturing Co., Fresno, California; Allison Steel Manufacturing Co., Phoenix, Arizona; Avco Corporation, Crosley Division, Richmond, Indiana.

Features like these make the LINK-LOCK ideal for use on military cases made to rigid specifications as well as on inexpensive commercial containers:

- Impact and drop resistant.
- Positive-locking without springs.
- High preloading and high load carrying capacity.
- Compact design—lies flat open or secured.
- 3 sizes, for heavy, medium, light duty.
- Flexible engagement latch design...can be varied to suit different applications.

Write for Catalog #760. Contains complete details of LINK-LOCK and other Simmons Fasteners with unlimited money-saving applications. Samples and engineering service available on request.



Half-turn applies high closing pressure, counter-turn disengages for opening. LINK-LOCK lies flat open or closed.

SIMMONS
FASTENER CORPORATION
North Broadway, Albany 1, New York
QUICK-LOCK • SPRING-LOCK • ROTO-LOCK • LINK-LOCK
DUAL-LOCK • HINGE-LOCK

Circle 99 on Reader-Service Card for more information

BASIC GRAPHICAL KINEMATICS is an extremely lucid text in this basic field of engineering. It will be found useful particularly for short courses to be given to draftsmen or technicians but will serve just as well as a handy reference for working engineers. It is the most comprehensive explanation we have seen to date, particularly on the subject of cams and gear trainings. The approach on epicyclic gear trains is unusually interesting because of its simplicity. The chapter on miscellaneous mechanisms uses a number of clear illustrations from industry to describe various types of variable speed drives, couplings and other mechanical components. By Harold B. Kepler, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N.Y.; 314 pages; $6.

INTRODUCTION TO CERAMICS fulfills a basic need in the field of physical ceramics and provides a new approach in an introductory ceramics textbook. Ceramics are considered as a class of materials rather than the product of a special industry. The book is based on a rational approach to ceramics phenomena properties—densification during firing and strength. Traditional ceramic compositions and recent space age uses and functions of ceramics are placed in proper perspective. The publication contains a considerable amount of material which just recently has been investigated and reported in technical literature, much of which is important for current and developing ceramic applications. The author has included his own opinions, many of which have not been proved and may change in the future. W. D. Kingery; John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y.; 781 pages; $15.

PLASTICS occupy a role of major significance in nuclear science technology. They stand beside metals and ceramics as one of the principal classes of materials used in the construction of apparatus. PLASTICS IN NUCLEAR ENGINEERING is the 20th materials book to be published by Reinhold. James O. Turner has written this publication from the viewpoint of the engineer who has the responsibility both of designing Bevatrons and reactors, bubble chambers and "Perhapsatrons" (experimental thermonuclear devices), and of making them work. You will find in it no history, no chemistry and no mathematics. It contains only discussions of a number of plastics applications that have been of value in the nuclear field and of the effect of radiation on plastics. This 139-page application guidance book is written in the usual Reinhold semitechnical style. Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y.; $5.50.

"For want of a nail..." The same burden may often fall on the tiny O-Ring. In overall product reliability the smallest parts are vital to performance. That's why IPC uses the famed "custom" approach in designing and manufacturing O-Rings.

Analyzing your application in terms of extensive compounding experience . . . IPC then customize tooling and manufacture under the most exacting quality control standards in the O-Ring industry.

Next time, in fact *anytime,* you suspect O-Rings are a critical factor in product performance, ask your IPC sales engineer to lend a hand. He has some interesting data which can help you evaluate O-Ring performance!

IPC

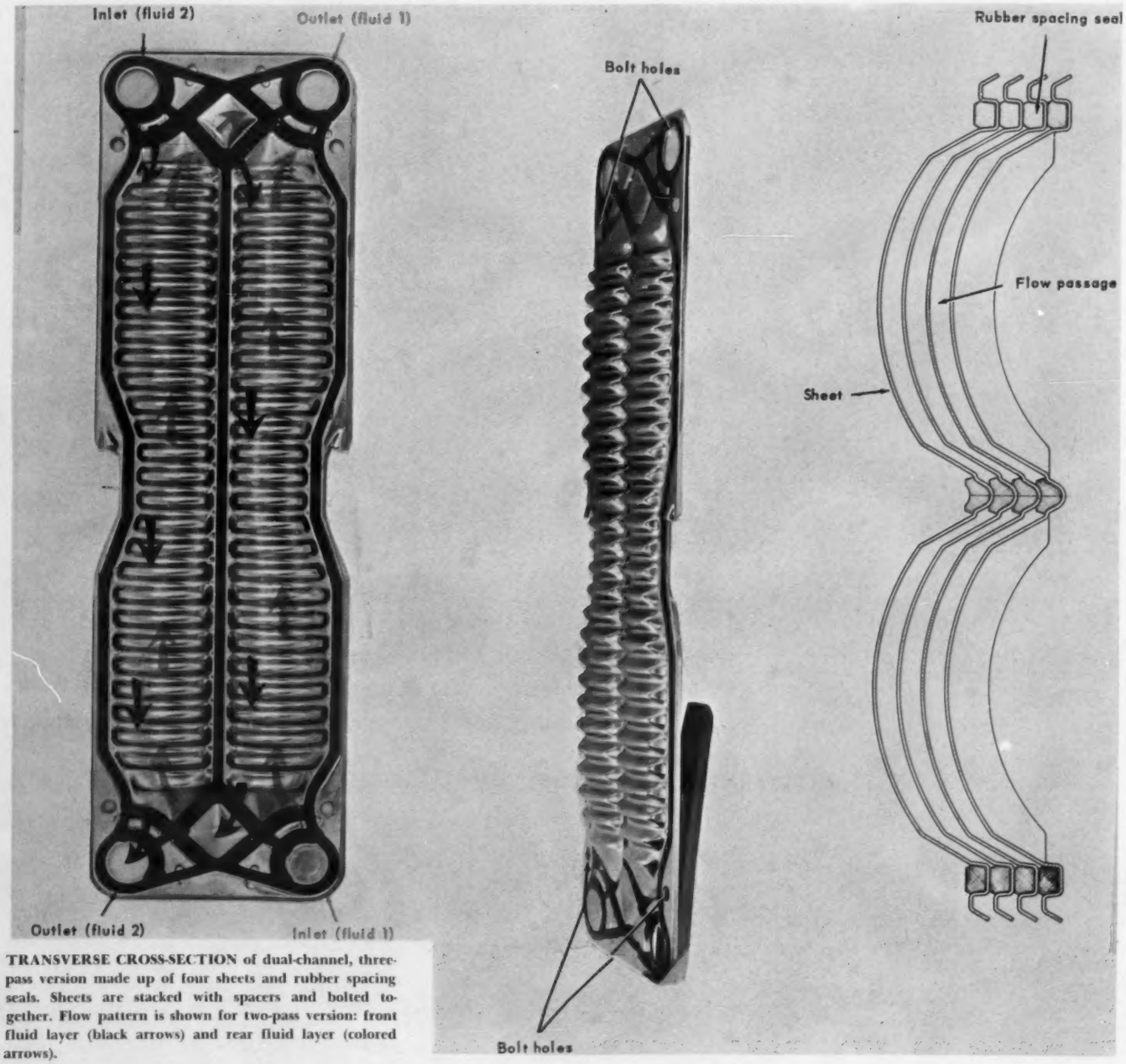
OIL SEALS
PACKINGS
PRECISION MOLDING *Custom designed for your application*

INTERNATIONAL PACKINGS CORPORATION
Bristol, New Hampshire

©IPC P4

Circle 100 on Reader-Service Card for more information

Shaped Sheets Form Novel Heat Exchanger



TRANSVERSE CROSS-SECTION of dual-channel, three-pass version made up of four sheets and rubber spacing seals. Sheets are stacked with spacers and bolted together. Flow pattern is shown for two-pass version: front fluid layer (black arrows) and rear fluid layer (colored arrows).

HILDESHEIM, GERMANY—A novel heat exchanger is assembled from several parallel sheets of electrolytically polished chromium-nickel steel. Sheets, uniformly spaced by shaped rubber sealing strips, have transverse corrugations which give strength to the unit and withstand fluid pressure without significant deformation.

Fluids, confined to spaces between corrugations of parallel sheets, continuously change direction. Formation of large separation zones is prevented. Average fluid layer thickness is 4.7 mm which keeps pressure drop low. Compared to the conventional plate-type heat exchanges, improved heat transfer is claimed with cold-end temperature differences of as little as 3C in water aftercoolers.

Absence of welds eliminates corrosion. As no struts, spacers or bolts obstruct flow passages, clogging is minimized, permitting application even when fluids contain fibrous material.

Units are available in several sizes. They are normally assembled for vertical flow on horizontal pipes which serve as fluid inlet and outlet passages. The heat exchanger is a development of Eduard Ahlborn AG.

R.F.S.

Steel Balls Transmit Torque In Centrifugal Clutch

ERLANGEN, GERMANY—A centrifugal friction clutch uses steel balls to transmit torque from driving to driven shafts. The driven shaft ends in a hollow cylindrical section which contains six straight vanes attached to the driving shaft. The resulting chambers are partly filled with steel balls.

As the motor shaft begins to rotate, balls accumulate against the forward face of each vane. With increasing shaft speed, the balls move centrifugally toward the surface of the driven housing. At full speed, balls form a peripheral layer, which in each chamber increases in depth toward the driving vane. Force is transmitted by contact pressure from vane to steel ball cluster and from there by friction to the housing walls.

While the function of this clutch is similar to that of a fluid clutch, it has several advantages. The steel balls, lubricated only with a heated-resistant graphite mixture, last longer than hydraulic clutch fluids. Wear on all contact surfaces is small and construction is simple. The gap between vane tips and housing can reach an appreciable fraction of the ball radius without causing excessive slip loss; this permits the clutch to operate without compensation for thermal expansion.

The clutch is a development of Siemens-Schuckertwerke AG. R.F.S.

An example of Avisco Rayons in Industry

What do you want to filter better?

The new Avisco® rayons have physical, mechanical and chemical properties of importance to the filtration field.

Being man-made, Avisco rayon fibers can be held precisely to the lengths and diameters desired. This facilitates processing—wet or dry—and improves control of porosity, stiffness and bulk of the filter mat.

Avisco rayon has good resistance to most gases, most of the common organic compounds, and inorganic materials with the major exceptions of concentrated mineral acids, hot dilute mineral acids, concentrated caustic alkalies and certain powerful oxidizing agents.

Write for Avisco Technical Bulletin G-15, containing properties, applications and samples of filter webs made of Avisco rayon. Use the Quick Reply Coupon at right.

QUICK REPLY COUPON 9-10

Industrial Merchandising Division
American Viscose Corporation
350 Fifth Avenue, New York 1, N.Y.

Please contact me about Avisco Rayons for use in the following application:_____

Name_____

Company_____

Address_____

City_____ Zone____ State_____

AVISCO® RAYON

AMERICAN VISCOSE CORPORATION, 350 Fifth Avenue, New York 1, N. Y.

Circle 101 on Reader-Service Card for more information

Unburden your engineering staff of the costly...time-consuming job of lettering and drawing recurrent symbols *again and again.* Use amazing...new STANPAT tri-acetate sheets, pre-printed with your standard blueprint items, that can be easily and quickly transferred to your tracings by an adhesive front or back. No special equipment required. Reproductions come out crisp and clear. Used by thousands of leading firms to save expensive drafting time–and to free engineers for more creative work. Available in two types of adhesive backs to meet any application requirement: (1) Rubber base for standard drafting and tracing paper–and (2), resin base to prevent leaching for papers that contain oils. **For complete details–and to obtain your *FREE TRIAL STANPAT SAMPLES*– fill out and mail this coupon.**

Use the 3-Step STANPAT METHOD for Repetitive Blueprint Items That Appear Again and Again

1. PEEL the STANPAT from its backing.
2. PLACE the STANPAT into position on the tracing.
3. PRESS into position –will not wrinkle or come off.

STANPAT COMPANY

STANPAT COMPANY
150-42 12th Road
Whitestone 57,
Long Island, N. Y.
Phone: FLushing 9-1693-1611

☐ Please quote on enclosed samples of our work.
☐ Kindly send me STANPAT literature and samples.

Name_____

Title_____

Company_____

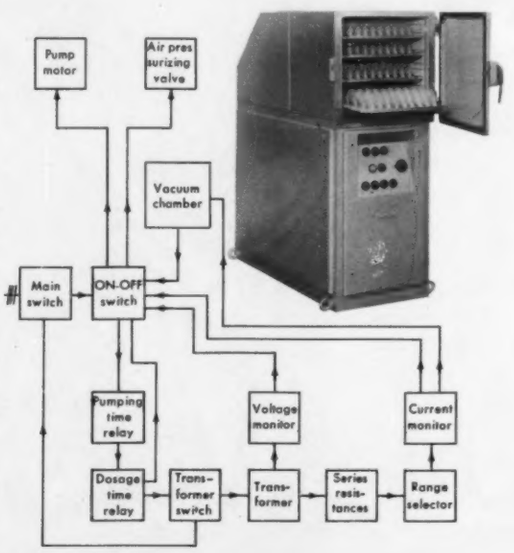
Street address_____

City_____ Zone____ State_____

Circle 102 on Reader-Service Card for more information

IDEAS IN THE NEWS

• **LOW-VOLTAGE GLOW DISCHARGE** at 0.5 Torr air pressure improves wear resistance and adhesiveness of polyethylene surfaces. Compared to conventional methods (gas flaming, electron bombardment), the new process has several advantages. The glow discharge adapts itself even to hollow shapes above 15 mm dia; material damage caused by overexposure is avoided; dust and electrical surface charges are removed.



The first commercial model has 125 liter capacity. Closing of vacuum chamber door starts automatic batch cycling: evacuation, dosage and repressurization. Glow discharge voltage is only 200-400v. Standard power source is 380v 3-phase, 50-cycle current. Energy consumption, including vacuum pump, averages 2.5 kva per batch. Dosage time varies with composition: low-pressure polyethylene requires twice as much as high pressure polyethylene. Unit has 560 by 1420 mm dimensions, is produced by Siemens-Schuckertwerke AG, Erlangen, Germany. **R.F.S.**

EPIALL molding compounds combine the inherent properties of epoxy resins with those of a wide range of fillers and reinforcing materials under Mesa's high standard of quality control. Dimensional stability is maintained at elevated temperature with freedom from out-gassing. High arc resistance (to 180 seconds), dielectric strength, and insulating capability are retained under conditions of extreme temperature and humidity. EPIALL compounds can be molded using conventional techniques. Good shelf stability (over four months without refrigeration), fast cure, hot rigidity, and fine mold release characteristics provide workability not found in other epoxy compounds. Please write direct for complete details of either conventional or "encapsulation grade" EPIALL molding compounds. Mesa Plastics Company, 12270 Nebraska Ave., Los Angeles 25, Calif. BR 2-4471.

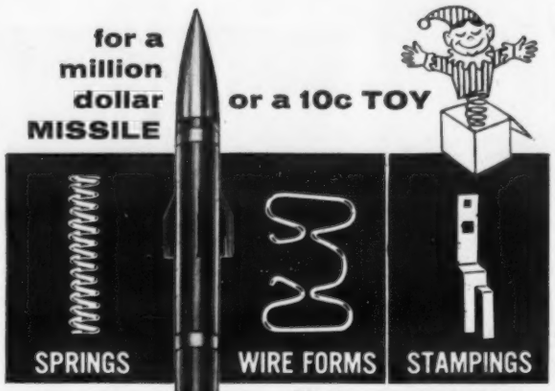
new reliability in epoxy

MESA EPIALL DIALL

Circle 103 on Reader-Service Card for more information

for a million dollar MISSILE

or a 10c TOY



Valuable FREE BROCHURE

Whether you require the close tolerance needed in a satellite—or the economical production necessary for a 10c toy . . . DUDEK & BOCK is your most dependable source for springs, wire forms and stampings. Years of know-how *quality control* guarantee you top performance at lower cost.

Phone* DICKENS 2-1020 *for estimates and delivery dates

DUDEK & BOCK
SPRING MANUFACTURING CO.
4014 W. GRAND AVE. • CHICAGO 51, ILL.

Circle 128 on Reader-Service Card for more information

NEW CURVE CROWN® STEPHENS-ADAMSON ONE PIECE ALL STEEL PULLEYS

FEATURING EXCLUSIVE "SPUN END" CONSTRUCTION

"SPUN END" CONSTRUCTION—Eliminates weldments in areas of high stress concentration, a major source of fatigue, warping and trouble. "Spun End" construction allows the placement of maximum metal thickness at end plate bore reducing unit pressures of radial loads while providing thin plate flexibility to accommodate shaft deflections.

CURVE CROWN DESIGN—Accurately formed CURVE CROWN on outer ends of rim eliminates conventional center peak—a high point for belt stretch and wear—while increasing belt training effect more than 100%.

PATENTED

SQUEEZE LOCK HUB—Design effectively transfers loads from rim to hub and from hub to shaft. Hub provides for full torque transmission without the use of keyways and eliminates distorting loads against pulley "Spun End." The SQUEEZE LOCK Hub exerts locking forces in two directions—to both shaft and pulley end plates—through a self-contained hub.

S-A

WRITE FOR BULLETIN 1160

PRODUCTS DIVISION
STEPHENS-ADAMSON MFG. CO.
29 RIDGWAY AVENUE • AURORA, ILLINOIS
PLANTS LOCATED IN:
LOS ANGELES, CALIF. • CLARKSDALE, MISS.
BELLEVILLE, ONTARIO • MEXICO CITY, D. F.

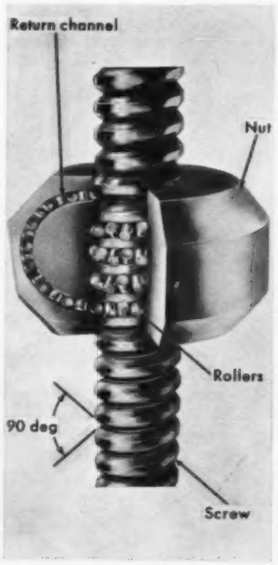
Circle 141 on Reader-Service Card for more information

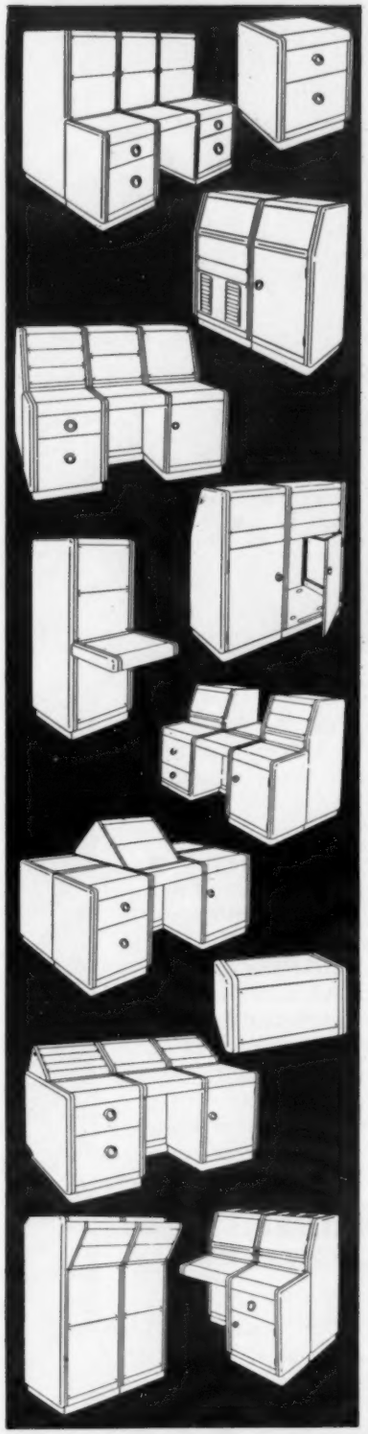
• **ROLLERS INSTEAD OF BALLS** are used in a new screw-and-nut mechanism to achieve several advantages. Higher loads are carried by smaller units because rollers distribute loads to many line contacts, in contrast to the point contacts of balls. Roller screw and nut are said to be easier and cheaper to machine, since threads are flat helixes instead of semicircular grooves.

High precision, very small play and no resonance are claimed to make speeds over 10,000 rpm possible. A 2-inch-dia screw is rated at more than 7-ton axial load.

Designer and manufacturer of this device is Sté. M.O., 250, Bd. de la Boissiere, Montreuil, Seine, France. U.S. patent has been granted.

G.B.B.





HUNDREDS OF Widths, Depths & Heights TO MEET YOUR ENCLOSURE REQUIREMENTS WITH EMCOR STANDARD CABINETS

- Cut costly enclosure design time. Select your packaging needs from a complete line of standard and heavy duty EMCOR Cabinets.
- EMCOR MODULAR ENCLOSURE SYSTEM Cabinetry provides for thousands of control center combinations.
- Engineered simplicity of basic frames and components affords quickest and easiest erection of control center assembly.
- EMCOR Cabinetry Engineers backed by the research and development "know-how" of the Roy C. Ingersoll Research Center set the pace for the packaging needs of electronics, instrumentation and electro-mechanical engineers from coast to coast.
- Rugged frame construction surpasses all standard requirements for increased load carrying capacities.
- Compatible cabinet design assures simplified and economical expansion at any time.
- EMCOR Cabinet manufacturing meets rigid quality-controlled craftsmanship standards.
- Nationwide organization of EMCOR Sales-Engineering Representatives assist in planning stages and assure customer satisfaction beyond the sale.

Condensed Version of Catalog 106 Available Upon Request.

Originators of the Modular Enclosure System

INGERSOLL PRODUCTS
Division of Borg-Warner Corporation
1000 W. 120th ST. • DEPT. 1239 • CHICAGO 43, ILLINOIS

QUALITY EMCOR PRODUCTS — INGERSOLL BW PRODUCTS

BORG-WARNER

Circle 104 on Reader-Service Card for more information

"Special" WEBBING at Standard PRICES

Buy from America's biggest selection of widths, weights, materials, styles, solid colors and patterns . . . all at low STANDARD PRICES.

No matter what product you make that requires webbing, we'll wager we have the exact width, weight, style and color you require. And . . . we can probably sell it from our STANDARD price list, too . . . not a SPECIAL price list, as happens with most manufacturers. We are America's oldest manufacturer of webbings. Huge line includes rayon, nylon, dacron, dynel, cotton, jute, combed peeler mercerized and high tensile webbings. Let us send you the facts!

Send for LITERATURE, SAMPLES, and PRICES

If possible, send us sample to match. Send for Free Folder.

BWB

BUFFALO WEAVING & BELTING CO., INC.

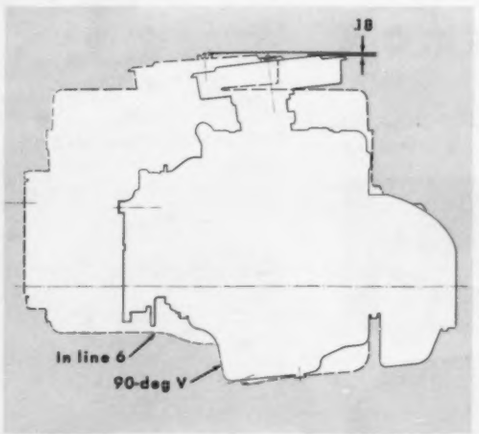
206 CHANDLER ST. • BUFFALO 7, N. Y.

We also manufacture a complete line of WEBBINGS *and* PURE SHEET RUBBER

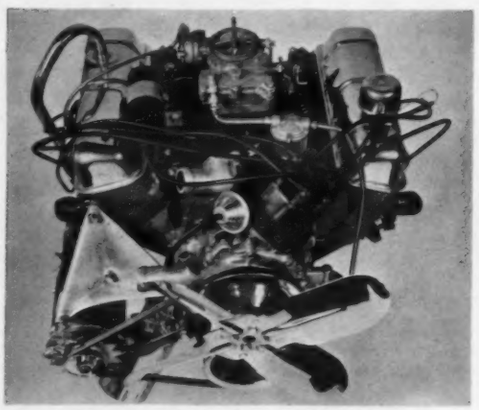
Circle 105 on Reader-Service Card for more information

IDEAS IN THE NEWS

BLOCK AND HEAD are of cast iron. Crankshaft and connecting rods are of Pearlitic malleable iron. Maximum brake horsepower rating is 135 bhp at 4600 rpm; maximum torque is 205 at 2400 rpm.



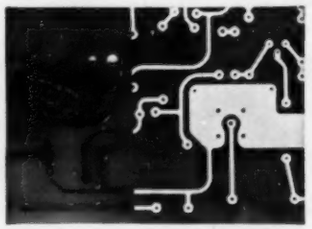
COMPARISON OF V-6 AND TYPICAL IN-LINE 6 PROFILES shows compactness achieved by 90-deg V-6 arrangement.



Straits Tin Report

Chemical tinning enhances the solderability of the conductive paths of printed circuits. Pure tin is deposited only on metal surfaces, including exposed edges; dielectric properties are unchanged.

The new process, using "CUPOSIT LT-26," made by Shipley Co., Inc., Wellesley, Mass., is not a substitute for electrodeposited tin, but it affords protection to the printed circuit board, thereby increasing storage life. "CUPOSIT LT-26" operates at temperatures lower than hot tin dipping, requires no electricity, contains no cyanide.



Bright side of printed circuit shows results of immersion in new chemical tinning process.

Tin Developments

- *Stronger titanium* results from addition of 15% tin. Ultimate tensile strength increases 90% at room temperature.
- *High-temperature brazing filler* metal alloys of tin, nickel, chromium, silicon keep joints strong after long exposure at high temperatures.
- *Low-melting quaternary* alloys of tin, indium, lead, silver are used for cryogenic circuits.

Free Bulletin

Write today for a free subscription to TIN NEWS—a monthly bulletin on tin supply, prices and new uses.

The Malayan Tin Bureau

Dept. T-26K, 2000 K Street, N.W., Washington 6, D.C.

Circle 106 on Reader-Service Card

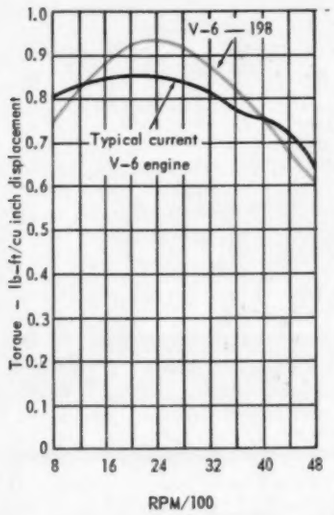
• BUICK SPECIAL 4000 SERIES CARS will use a cast-iron, 90-deg, V-6 engine.

The 90-deg layout makes possible a lighter, more rigid and more compact unit than the in-line V-6. The shortness of the crankshaft also minimizes roughness and engine vibration.

Basic engine configuration is patterned closely after the companion 215-cu-in, Special aluminum V-8. The bore has been increased to 3.625 inches and the stroke to 3.200 inches. Displacement is 198 cu in.

The V-6 also uses a slanted, saucer-type combustion chamber similar to the V-8, which permits operation at 8.8:1 compression ratio on regular grade gasoline.

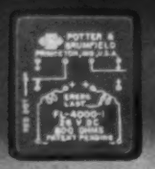
The 90-deg, V-6 configuration results in a weight savings of from 140 to 179 lb over current in-line sixes of comparable power. In addition, it also provides a substantial gain in power output in the 25- to 80-mph speed range, as compared with current in-line sixes. E.J.S.



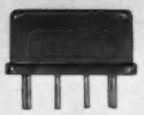
TORQUE—LB-FT PER CUBIC INCH DISPLACEMENT CURVE is shown in comparison with curve considered typical of current V-6 engines.

Circle 107 on Reader-Service Card

a New and superior latching P&B relay



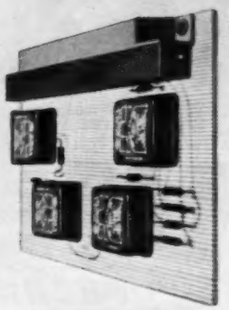
LIES FLAT FOR GREATER PACKAGE DENSITY, HIGHER PERFORMANCE



This DPDT, permanent magnet, latching relay is superior on these counts: (1) shorter height for maximum compactness between stacked circuit boards; (2) greater sensitivity (80 milliwatts); (3) better vibration resistance (30 g to 2000 cps); (4) better shock resistance (100 g).

Designated the FL Series, this relay meets all applicable sections of MIL-R-5757D, MIL-R-6106C and ABMA #PD-R-187.

Call your nearest P&B representative today for complete information about the whole P&B family of microminiature relays.



Printed circuit board using 4 FL relays was designed by the Martin Company, Orlando, as part of ground support equipment for a major missile project.

FL SERIES SPECIFICATIONS

Contact Arrangement: DPDT

Shock: 100 g for 11 milliseconds with no contact openings.

Vibration: .195; max. excursions, 10 to 55 cps. 30 g from 55 to 2000 cps. No contact openings.

Linear Acceleration: 400 g minimum with no contact openings.

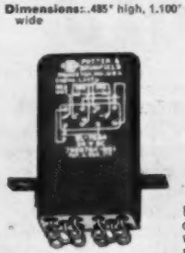
Pull-In: 150 milliwatts, approx. (standard) at 25°C. coil temperature.

80 milliwatts, approx. (sensitive) at 25°C. coil temperature

Operate Time: 3 milliseconds max. at nominal voltage at 25°C. coil temperature

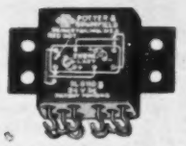
Dimensions: .485" high, 1.100" long, .925" wide

THERE'S A P&B CRYSTAL CASE RELAY FOR YOUR PROJECT



Diode in relay case is used for arc suppression in special applications. Four diodes form full-wave bridge rectifier for 400 cycles.

Non-latching or latching relays in conventional crystal cases with or without shoulder brackets, studs or mounting plates. All types of terminals are available.



Terminals spaced on .200" grids are available on all P&B microminiature relays. These carry a "G" suffix (SCG and SLG) and are .890" high, .800" wide, .400" deep, max.

These 3 relays are shown slightly reduced in size.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONICS PARTS DISTRIBUTOR

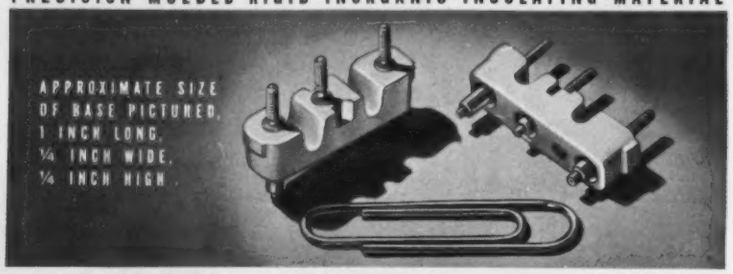
POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY • PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO

Here's How Haveg Solved the Problem... with HAVELEX®

PRECISION MOLDED RIGID INORGANIC INSULATING MATERIAL



This miniature switch base molded with Havelex, contains four different stainless steel inserts with precious metal plating. Three inserts (which include #0-80 male threads) go all the way through the mold and provide precision mountings on both sides for assembly. The #0-80 female threaded insert is designed to protrude from one face and is approached by a molded counterbore from the other. Mold is designed to accommodate alternate terminal inserts when unthreaded models are required.

Haveg engineers recommended Havelex for this particular molding because of its combination of properties. Completely inorganic, with metal inserts integrally molded in place. Precision tolerances with faithful reproduction from part to part. Heat resistance for continuous operation in excess of 700°F.

Haveg engineers will be happy to work with you on your particular project—to help you "Keep ahead with Haveg." *Remember*—Havelex offers all of these unique features: **Dimensional Stability • 1000°F. Continuous Temperature Resistance • Dielectric Strength • Mechanical Strength • Low Loss, Low Power Factor • Arc Resistance • No-Moisture Absorption • Integrally Molded Metal Inserts • Hermetically Sealed Inserts.**

Keep Ahead with HAVEG. FIRST IN *Engineered* PLASTICS

TAUNTON DIVISION
HAVEG INDUSTRIES, INC.
336 Weir Street • Taunton, Massachusetts
Telephone VAndyke 4-4011

Circle 108 on Reader-Service Card for more information

DIFFERENTIAL SPECON GEAR BOXES

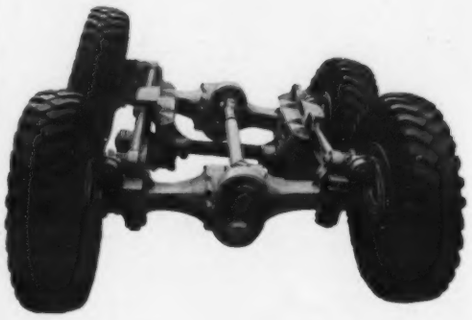
Differential assemblies precision crafted by Specon for drives and transmissions are available as gear boxes alone. These task-proven assemblies offer the built-in advantages of Specon units: extreme accuracy, low maintenance, rugged, space saving construction. Seven basic models are rated from 1 hp. to 75 hp. Specials and units for higher power can be supplied. The Specon units are particularly well suited for such applications as phase and register control, speed control, torque dividing, overriding, cycling and balancing operations.

For full information on Specon gear boxes, drives and transmissions, write to:

STRATOS®
A DIVISION OF FAIRCHILD ENGINE AND AIRPLANE CORPORATION
Industrial Products Branch, Route 109, West Babylon, L. I., New York

Circle 109 on Reader-Service Card for more information

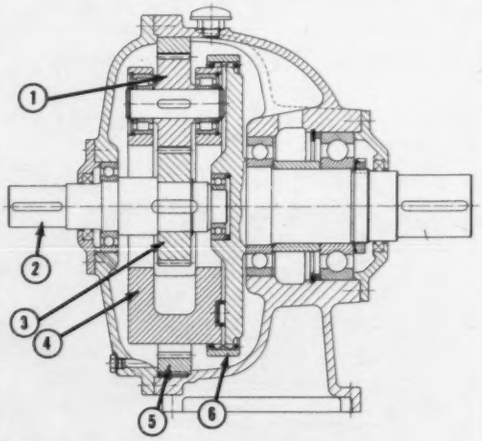
IDEAS IN THE NEWS



• **HUB PLANETARY GEARS** installed in a heavy-duty tandem axle save weight, increase ground clearance. As 5 to 1 stepdown ratio is accomplished directly at the wheel, less strength is needed for torque transmission in preceding elements of the power train. A part of the planetary gear housing also serves as wheel hub.

Gear units are standardized to match tire size, can be adapted to varying service torques and speeds by changing axle centers only. Tandem axles are produced as units, bolted directly to the chassis frame. Load is distributed to axles from frame plate support faces through links carried in movable bearings. Spherical thrust pieces allow links to follow axle movements. Reaction moments of axles are absorbed by torsion bars supported in rubber bearings.

The planetary gear axles are a development of Rheinstahl Eisenwerke Muelheim/Meiderich AG, Muelheim (Ruhr), Germany. R.F.S.



(1) Satellite
(2) Propeller shaft
(3) Sun wheel
(4) Satellite carrier
(5) Internal geared wheel
(6) Gear coupling

Luster-on®

THE FIRST AND FINEST IN CONVERSION COATINGS FOR BRASS, ZINC, CADMIUM, COPPER, ALUMINUM

The Chemical Corporation offers a complete line of uniform-controlled chromate conversion coatings that provide maximum protection in one, low-cost, simple operation. Available for immediate delivery as liquids or powders.

always specify luster-on

FOR BRILLIANT CORROSION-RESISTANT FINISHES . . . rivaling chrome for many applications where cost is a factor. Long-lasting, easily controlled application.

FOR CLEAR, BRIGHT and IRIDESCENT COATINGS . . . gives striking, attractive appearance with complete corrosion-protection . . . even when humidity and handling are involved during processing. Also yellow iridescent and olive drab for concealed parts or as a paint bond.

FOR DECORATIVE COLOR . . . on low-cost zinc. Brilliant golds, yellows, blues, greens, violets, reds, brass and copper hues.

FOR ALUMINUM . . . replacing costly anodizing where surface hardness is not of prime importance. Excellent finish for paint bonding. Save 25% or more with Luster-on complete package treatment: cleaners, de-oxidizer, sealer.

FOR LASTING BRIGHTNESS . . . on both copper and brass without noxious fuming.

FOR DIE-CASTINGS . . . one quick dip provides uniform finish, ideal as a base for painting.

We'd like to show you what Luster-on can offer you! Send in sample part today for free processing. Data sheets on request.

BLAKODIZE* . . . chemical black treatment for steel, provides lustrous, rich, black finish with good degree of penetration and rust resistance.

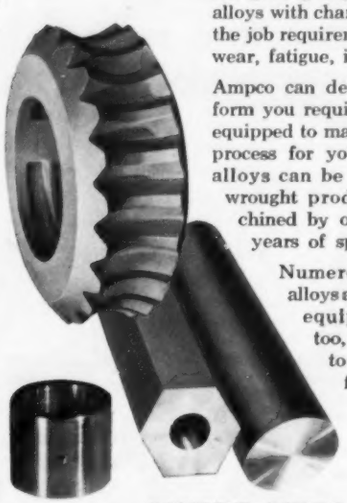
*T.M. Reg.

The Chemical Corporation

Circle 110 on Reader-Service Card

Longer life

for critical bronze parts—when they are made of AMPCO® alloys



When you select Ampco alloys, you are getting *engineered materials* — alloys with characteristics that match the job requirements for resistance to wear, fatigue, impact, corrosion, etc.

Ampco can deliver the shape and form you require, because Ampco is equipped to manufacture by the *best* process for your purpose. Ampco alloys can be obtained as cast or wrought products, and finish-machined by one organization with years of specialized experience.

Numerous parts of Ampco alloys are specified in original equipment. Maintenance too, employs Ampco alloys to reduce downtime. Ask for an Ampco Engineer to call — or write for literature.

AMPCO METAL, INC. 6-29A
Dept. 441 Milwaukee 1, Wis.
West Coast Division: Huntington Park, California
Southwest Division: Garland (Dallas County), Texas

Circle 130 on Reader-Service Card for more information

PROBLEM:
Torsion Fatigue in Rubber Hose
SOLUTION:
CHIKSAN
SWIVEL JOINTS
Chiksan Swivel Joints, with free turning 360° rotation allow hose lines to be flexed without the twist caused by fixed position fittings. With Chiksan Swivel Joints hose lines last longer, maintenance and downtime are virtually eliminated.
Send for Illustrated Catalog.
CHIKSAN COMPANY
BREA, CALIF., CHICAGO 5, ILL., NEWARK 2, N. J.

Circle 111 on Reader-Service Card for more information

• RADIATION PYROMETER, capable of continuously measuring surface temperatures of metal fans (from 650 to 750C) traveling at rates up to 20 fpm, has been developed by The United Kingdom Atomic Energy Authority, London England. Measurement is obtained in a narrow band (1/2 to 3/4 inch) between a heating and a quenching zone. A heat radiation transmission path is provided by a fused quartz rod, the receiving end of which is shaped like a fishtail and partly encircles the bars. At its other end is a lead sulphide photocell.

The quartz rod has two breaks. The first is for a rotary radiation chopper in the form of a slotted disc turning at a speed to give a chopping frequency of 1000 counts per sec. The second is for a radiation chopper having alternate blades of plastic and germanium and giving a 10 cps frequency.

Furthermore, the rod transmits radiation over the wavelength interval from 0 to 2.5 microns, the plastic blades of the second radiation chopper from 0 to 2 microns. Thus, the lead sulphide cell receives alternate signals at 10 per sec on a 1000 cps carrier signal.

The current from the cell is amplified and rectified and the two d-c levels corresponding to the two wavelength intervals are fed to a switch. The resulting signals are smoothed and transmitted to the slide wire and pointer of a potentiometer and presented to the ratio recorder of this device. The reading at the recorder is a function only of the bar surface temperature. R.W.E.M.

MEEHANITE MEANS BETTER CASTINGS®

Standard construction materials for all Blackmer Vari-Flo pumps is high strength, pressure-tight Meehanite Nodular Iron. It provides the necessary mechanical properties and is less costly than steel, particularly from the standpoint of machining. The intricate rotor shown, a critical internal part subject to high stresses, is cast in type SP-80 to insure top performance under the most severe service conditions.

SOLVE YOUR TOUGH CASTING PROBLEMS WITH MEEHANITE NODULAR

The excellent castability of Meehanite Nodular in combination with exceptional strength, ductility and wear resistance has led to its wide acceptance for intricate pressure castings and many other components which must withstand severe service conditions. The broad range of its utility is further enhanced by inherent production advantages resulting in a reduction of manufacturing costs.

Meehanite Nodular is available in a broad range of properties embracing all current Nodular specifications and including some unique new wear and heat resisting types. When you specify one of the S types of Meehanite Nodular, you can be sure of obtaining castings that live up to specified claims. Meehanite foundries have more than a quarter of a century of experience in handling the essential materials used to convert the graphite in cast iron from the flake form to the nodular which gives this family of metals its unique engineering properties. Meehanite patented quality controls assure uniform dependability regardless of how small or how large the casting.

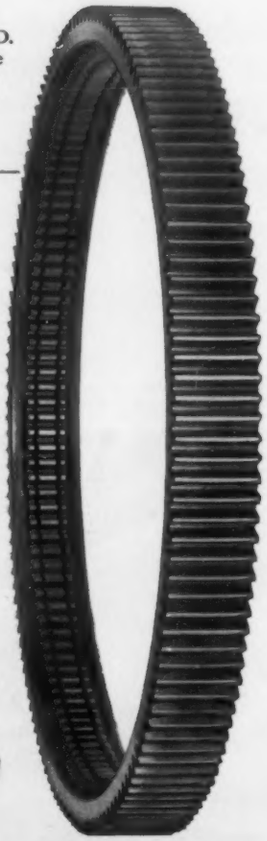
For complete information about Meehanite Nodular, send for a free single copy of our eight page brochure (B-47-A). Write: Meehanite Metal Corporation, 714 North Avenue, New Rochelle, New York.

MEEHANITE METAL

MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES.

Circle 112 on Reader-Service Card for more information

Snap-ring grooves in this 12" O. D. thin-section *Reduction Drive Gear* are machined before carborizing and hardening. Both spline and gear teeth are ground and held to .001" excentricity after hardening the entire gear.



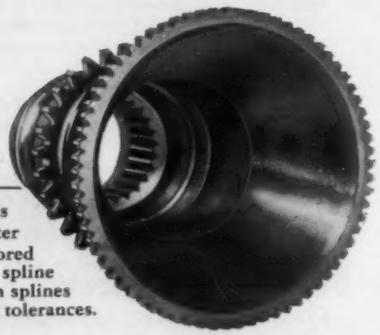
When you DRIVE for profits, GEAR with PERKINS

MACHINE AND GEAR CO.

Dept. 84 West Springfield, Mass.

Men who *know* will tell you that custom precision gears made by Perkins can eliminate many design, production and maintenance headaches — literally help you drive for better profits. When you want precision gears in experimental or production quantities, chances are you'll save time and money by checking with Perkins first. What is your gear problem today?

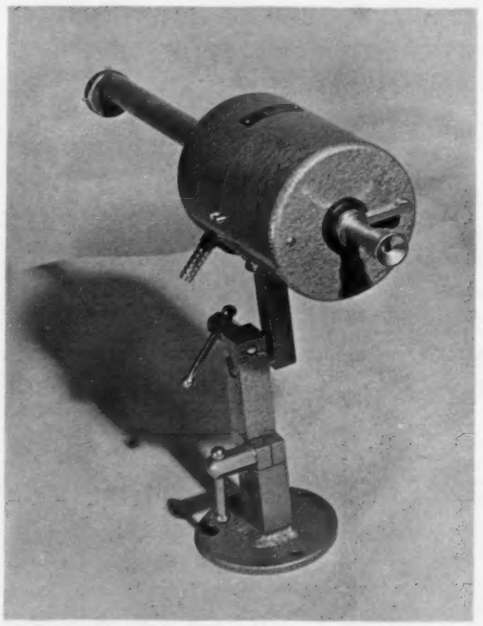
This Handy Gear Calculator, easy to use, saves time. *Folder* illustrating Perkins custom precision gears and facilities offers information. Both yours on request.

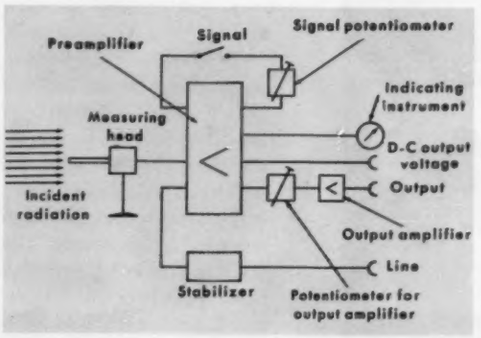


Most machining operations on this *Drive Gear Shaft* are performed after localized hardening with the cored areas at Rockwell C42. External spline and gear teeth are ground with splines held to precision tolerances.

Circle 113 on Reader-Service Card for more information

IDEAS IN THE NEWS

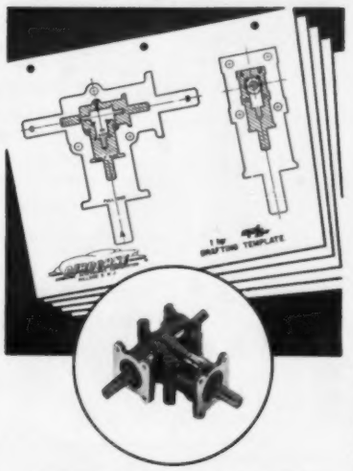




free TO ENGINEERS!

ANGLgear

DRAFTING TEMPLATES



To simplify the job of incorporating ANGLgear in your power transmission systems, we offer free to designers this set of five precision tracing templates. Wherever you have a 90° drive problem in the ⅓ to 5 hp range, you can usually solve it quickly and economically with ANGLgear, the *original* standardized right-angle drive.

You get one template each for the ⅓, 1 and 2¼ hp ANGLgear models, plus separate plan and end views for the larger 5 hp unit. For added convenience in scaling, templates are reproduced in full, half and quarter size.

Over the past 10 years, ANGLgear has been specified increasingly by design engineers—for applications ranging from simple manual control of valves to classified installations aboard nuclear submarines. ANGLgear is available from your local distributor's stock in 4 sizes, 16 models, with your choice of 1:1 or 2:1 gear ratios and 2 or 3-way shafting. See him or write for Catalog IA-58.

AIRBORNE®

Engineered Equipment for Aircraft and Industry

AIRBORNE ACCESSORIES CORPORATION

HILLSIDE 5, NEW JERSEY

Circle 114 on Reader-Service Card

• **AN ELECTRONIC RADIATION PYROMETER** records both temperature and production rate of hot-rolled sheets in a steel mill. Unit has 5-millisec response time, retains short signal from fast-moving sheet in a condenser unit. Strip recording with time marks shows temperature (peaks) and output (number of peaks per hour).

The measuring head contains no lenses or mirrors on which radiation-absorbing deposits could form. Incoming radiation, modulated by a rotating chopper disc, impinges on an IR-sensitive element. After preamplification, the resulting voltage is displayed and recorded. Short signals of 20 millisec minimum duration are held constant in a condenser storage section for a preselected delay time between 2 sec and 30 sec. This permits the more slowly responding mechanical parts of the display instrument and strip recorder to sense the signal without distortion.

For control purposes, an output amplifier delivers a d-c voltage of up to 50v and 150 mw. The preamplifier can be made to act as oscillator with adjustable voltage for simulation of input temperatures and off-line calibration of recording and control elements.

An integral 3-position output section with 30-millisec response time adapts the unit to control of high-frequency induction heating and quenching. Tight-beam measuring head permits sighting through turns of induction coil; as workpiece reaches preset temperature, 3-position control unit cuts heater, triggers quench.

Standard measuring ranges are 350-900C and 500-1200C at ± 1.5 percent accuracy. Minimum measuring area is of the order of ⅜-inch dia at 20-inch distance.

"U-Pyr" electronic pyrometer and "EPS 30" control section are developments of Uher & Co., Vienna, Austria. R.F.S.

Circle 115 on Reader-Service Card

ENGINEERING NEWS-#8

SIX PUSHBUTTON SWITCHES

CHECKED *C.W.A.* | ENGR. *J.F.B.* | CONTROL SWITCH DIVISION

SUB-SUBMINIATURE

B7000 is only 1/32" diameter, 1¼" total length. Available with a bushing or flange mounting. Flange can be engraved. Anodized aluminum case, plastic plunger cap and solder lugs. Rated 1 amp at 28 VDC. The perfect pushbutton for subminiaturized instruments and control panels.

MOISTURE-PROOF, 6 CIRCUIT TYPES

W100 is available at S.P.S.T. (N.O. or N.C.), S.P.D.T., 2-circuit, and 3-terminal (N.O. or N.C.). Designed to MIL-S-6743, MS-25089. Completely moisture-proof and enclosed in anodized aluminum case with silicon rubber boot. Available with any of 8 mounting adapters (Adapter P shown) to meet any mounting or panel requirement. Rated 10 amps at 28 VDC resistive.

LOW COST, U.L. LISTED

B2000 series switches are considerably smaller than standard ½ amp momentary pushbuttons, yet cost much less and actually are U.L. rated at 8 amps, 120 VAC. Select S.P.S.T. circuit either N.O. or N.C., with solder lugs or pigtail leads. Mounts in ½" dia. hole.

WITH OR WITHOUT LIGHT

WC1500 is a very small moisture-proof switch (designed to MIL-S-6743) with a minimum life of 25,000 operations at rated load. Available with or without indicator light in pushbutton, and rated at 2 amp ind. or 4 amp res., 28 VDC. D.P.D.T. or 4-circuit. Mounts in ⅜" diameter panel hole.

MOISTURE-PROOF, ALTERNATE ACTION

J3136 is a new moisture-proof switch originally designed for military ground support and aircraft equipment. Two-circuits, rated at 5 amp ind. or 10 amps res. at 28 VDC: 5 amp (.75 P.F.) ind. or 10 amp res. at 120 VAC. Life is 25,000 operations min. at rated load. Anodized aluminum case with solder lug terminals, and 8 styles of mounting adapters available. Mounts in ⅝" dia. hole.

20 AMPS., PUSH-PUSH

J100 is a S.P.S.T. switch rated 20 amps res. at 28 VDC; 10 amps res. at 115 VAC. Ruggedly built to give compactness and durability under crictical operating conditions. Weighs only 1 oz. Total plunger travel is only ¼". Overall size: 1" diameter, 2 13/32" long.

The switches shown above are merely samples from the full line of CONTROL SWITCH pushbuttons. Perhaps one of these is a solution to a switching problem you face. If not, write for your **free** copy of CATALOG 100 for details on the wide range of switches available, including basic switches, toggles, lighted pushbuttons, indicator lights and many other types.

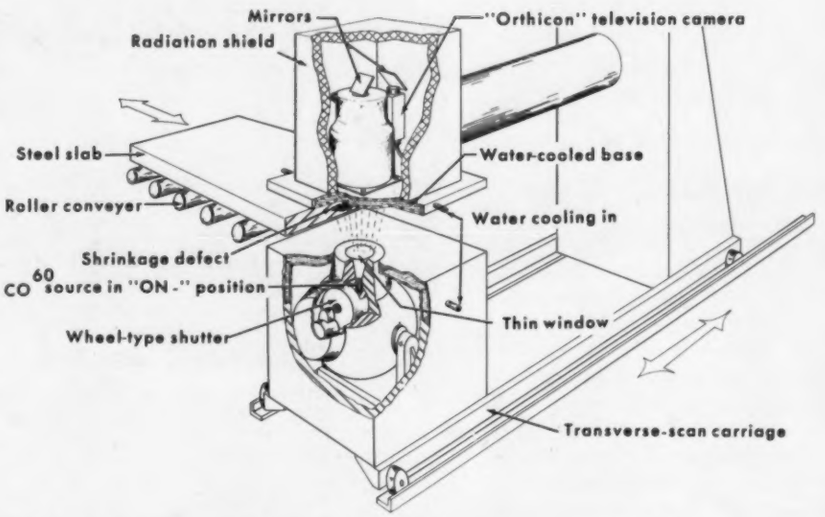
CONTROLS COMPANY OF AMERICA

CONTROL SWITCH DIVISION

Manufacturers of a full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading parts Distributors.

4226 W. Lake Street • Chicago 24, Ill. • Telephone: VAn Buren 6-3100 • TWX CG 1400

ENGINEERING NEWS -- Pushbutton Switches



GAMMA RAYS, produced by dime-sized piece of cobalt 60, pass through tube glass, impact lead layer and then strike adjacent photo-emissive phosphor. Lead booster, when impinged by gamma rays, creates electrons which reinforce effect on phosphor. Resultant phosphor illumination then energizes electron emitter. Electrostatic field, produced by focusing electrodes, mounted in tube, causes emitted electrons to converge on output phosphor and then be focused into television camera.

quick fastening of a wide range of materials

Designers, who have let their imagination soar, have discovered that a 50-year old belt fastening method is an exciting new method of fastening many other materials. This Clipper fastener achieves a uniqueness of design. It provides smooth, durable fasteners as flexible as the material . . . fasteners that ride over rolls and pulleys easily without pounding, when required.

For a new approach to hinging and fastening materials such as canvas, cardboard, plastics, rubber, aluminum, cloth, plywood, leather . . . try Clipper. Hooks are available in attractive Bronze, rust-proof Monel and Stainless Steel.

Why fret and fume over that fastening problem? Why not try Clipper and open up new areas of design flexibility. Let us help you experiment . . . send samples of the material you wish to join and we'll demonstrate how it can be done with Clipper fasteners.

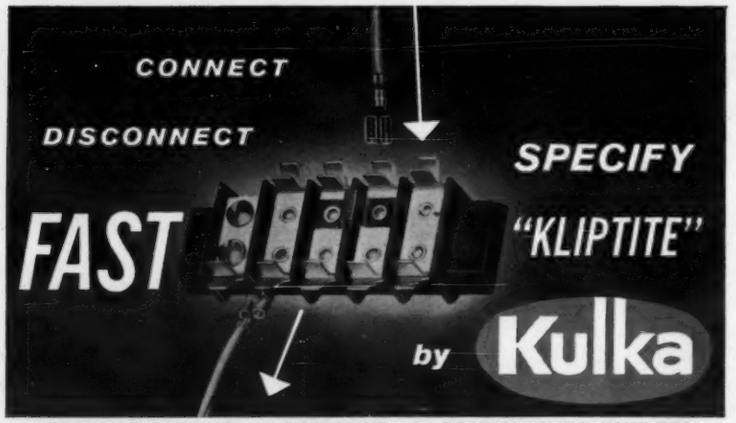
ASK TOO, FOR A COPY OF BULLETIN 259: "A GUIDE TO FASTENING SAVINGS".

Ask your Industrial Distributor for Clipper Products

Clipper BELT LACER COMPANY

974 Front Ave. N. W., Grand Rapids, Michigan

Circle 116 on Reader-Service Card for more information



TERMINAL BLOCKS • SWITCHES • CONVENIENCE OUTLETS

• Just clip on wire terminal fast—for a tight connection • Disconnect just as fast • Available on KULKA'S full line of molded barrier terminal blocks, plus switches and convenience outlets • Up to 6 connections per stage • Vari-angled tabs • Available riveted to terminal hardware or with screw assembly • Designed to accept female wire terminals made by AMP, BURNDY, KENT, and ARKLES.

For fast, reliable wire hook-up — and quick disconnect — KULKA'S versatile "Kliptite" terminals are unbeatable. That's why they are specified by leading manufacturers of appliances, air conditioners, vending machines, and countless other types of equipment. "Kliptite" male tabs are electro-tinned brass for low contact resistance. They may be supplied rigidly riveted to KULKA terminal hardware, or where termination to a screw is required on the same terminal, they may be assembled under the screwhead.

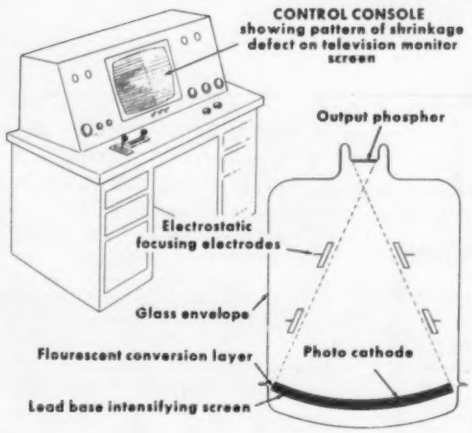
See for yourself how "Kliptite" terminals can improve your assembly operation.

Write for complete details . . .

KULKA ELECTRIC CORP.

633-643 SO. FULTON AVENUE, MOUNT VERNON, N. Y.

Circle 117 on Reader-Service Card for more information

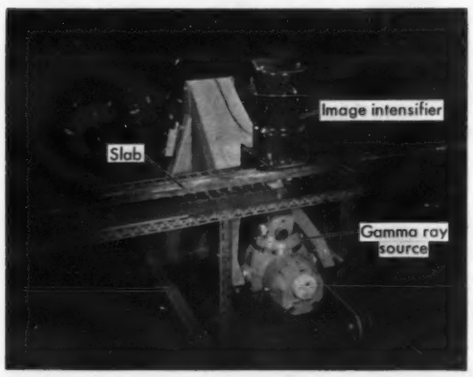


• **LEAD SHIELD WITH ALUMINIZED COATING** acts as a booster in the image intensifier tube of a gamma-ray flaw detector. The coating prevents contamination of the photo-emissive phosphor. Equipment can detect flaws inside assembly line products as thick as 4 inches of steel and project the image on television monitors.

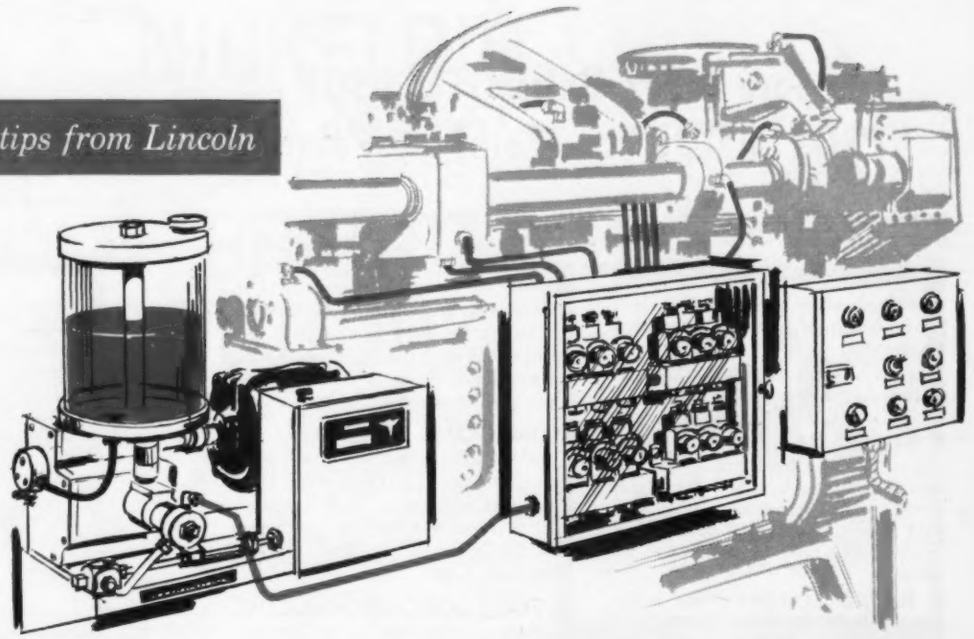
The nondestructive testing system permits continuous assembly-line inspection of dense material which previously could be inspected only by gamma-ray photographs. It is also applicable to other materials which could not be inspected without destructive testing.

With the gamma-ray image intensifier system, an operator simply watches a television screen to determine the exact location of defects in slabs of steel, for example, as the move along a conveyor. Excessive trimming then can be avoided since the precise amount to be sheared is shown on the screen. Method of visual inspection thus can effect substantial economies in quality control.

The gamma-ray system is applicable for inspection of solid-fuel rockets, nuclear reactors, castings and other metal objects too dense for X-ray testing. Equipment is a joint development of Picker X-Ray Corp., White Plains, N. Y., and Rauland Corp., Chicago, Ill. V.W.W.



Design tips from Lincoln



Provide automatic lubrication system with compact, reliable Electro-Luber®

Lincoln's Electro-Luber answers your need for a compact, reliable lubricant pump that's easy to design into machines of all types.

The high-pressure Electro-Luber feeds injectors that meter the exact amount of lubricant you specify directly to the individual bearings. Look how much flexibility you have with this system: 1) injector output is adjustable and you have a wide choice of capacities; 2) pump cycling frequency is adjustable; 3) you can tie Electro-Luber and machine controls together so lubrication is automatically scheduled with machine operation; 4) the Electro-Luber also has manual control for cycling prior to machine operation if desired.

Here's a tip to consider: Mount the injectors in a panel near your other controls and signals for easy visual inspection of every injector-to-bearing line.

An Electro-Luber system enhances the sales appeal of your machines, protects your customers by taking the human element out of machine lubrication, insures maximum service life for critical parts, saves maintenance costs, gives smoother operation and eliminates down-time for manual lubrication.

Note to Manufacturers: Lincoln will help you determine the best automatic lubrication system for your machinery. Contact the Original Equipment Sales Division.

Mail This Coupon Today!

Electro-Luber Model No.	Power Requirements: Motor	Power Requirements: Timer	Lubricant	Lubricant Pumping Pressure
1848	3 PHASE 220–440 V/AC	115 V/AC 60 Cycle	Oil	1000 PSIG
1849	3 PHASE 220–440 V/AC	115 V/AC 60 Cycle	Oil or Grease	2900 PSIG
700226	3 PHASE 220–440 V/AC	115 V/AC 60 Cycle	Oil or Grease	2500 PSIG

NOTE: All models conform with J.I.C. standards and National Electric Code.

LINCOLN ENGINEERING COMPANY
Original Equipment Sales Division
4010 Goodfellow Blvd., Dept. DN-9
St. Louis 20, Mo.

☐ Please send new Catalog 82 on Lincoln centralized lubricating systems.
☐ Have your representative call to advise on adaptation to my machines.

Name_____ Title_____
Company_____
Address_____
City_____ Zone____ State_____

LINCOLN ST. LOUIS

LINCOLN ENGINEERING COMPANY
ST. LOUIS 20, MO. • DIVISION OF THE McNEIL MACHINE & ENGINEERING CO.

Circle 118 on Reader-Service Card for more information

Compare Index Units! FERGUSON "PROVES OUT" . . . Point by Point.

Selection of components for a production machine should be based upon the machine's return per dollar investment. Matching "first costs" only does not generally result in the design of profitably operated equipment.

Here is a check list for comparison of indexing mechanisms. "Price" is shown in its order of consideration.

1. BACKLASH—None? Some during the dwell or index or both? *Any* backlash during *any* part of the cycle results in wear-causing vibrations and shock loads . . . *The Ferguson Drive maintains zero backlash at all times.*

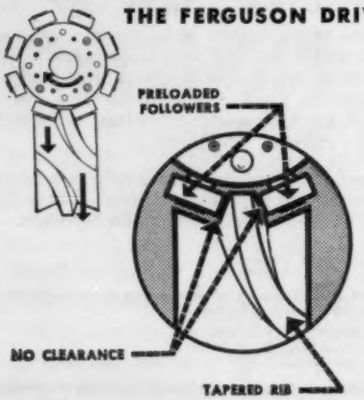
2. RATED LOADS—What is the rated life and under what load? What is the average follower life (B-10 life)? The Ferguson Drive is rated at maximum precision for at least 8,000 hours operation and with an average follower life of 90%. Replacement of the followers renews the life of the Drive for another 8,000 hours. Ferguson cams never wear out under rated loads.

3. JOB SUITABILITY—Can the acceleration characteristic be preselected according to job requirements or is it inherent in the mechanism or limited by the manufacturer? Acceleration of the Ferguson Drive can be chosen after an application evaluation to provide optimum operation.

4. INDEXING ACCURACY—Are time-consuming shot pins necessary for precision? . . . They soon wear and lose accuracy. The Ferguson Drive is positive locking and locating for extreme precision without shot pins.

5. FIRST COST vs. TOTAL COST—Now consider the higher production rates, better quality and much lower maintenance costs the Ferguson Drive gives you. Determine the *total cost* of the various indexing mechanisms. The Ferguson Drive has proved out . . . And you're on the way to building more profitable production equipment.

THE FERGUSON DRIVE



Cam features a tapered rib along which two standard cylindrical followers roll without clearance . . . *maintaining zero backlash during index and dwell.* While in the dwell or "work" position a straight portion of the cam rib locks the hub positively, without auxiliary locating or locking devices. *Extreme precision is inherent,* even at speeds as high as 2,000 indexes a minute!

CATALOG NO. 161 gives complete design data on nearly 100 standard indexing mechanisms, over 150 index tables and various auxiliary items. Send for your free copy . . . There's one for every design engineer.

ferguson®

FERGUSON MACHINE COMPANY

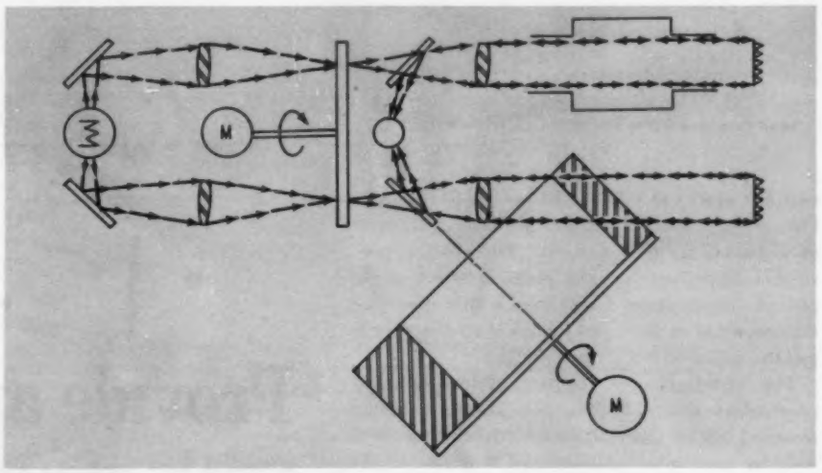
A Division of Universal Match Corporation

7818 Maplewood Court • St. Louis 17, Missouri

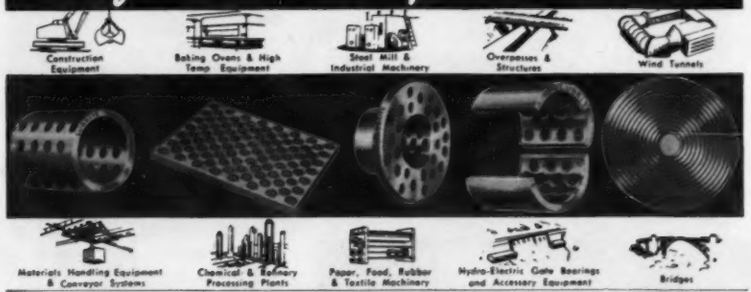
Circle 119 on Reader-Service Card for more information

• **ROTATING, RING-SHAPED GRAY WEDGE** is the novel compensating element of a self-balancing smoke meter. The device is insensitive to dust deposits on its optical elements. Light absorption in a measuring channel and a reference channel are compared automatically. The angle of rotation required for the gray wedge to equalize light absorption in both channels is recorded electronically and serves as smoke-density index.

In the optical section, two mirror-and-



ASSURED SELF-LUBRICATING SECURITY WITH LUBRITE® Self-Lubricating BEARINGS


Construction Equipment
Baking Ovens & High Temp. Equipment
Steel Mill & Industrial Machinery
Overpasses & Structures
Wind Tunnels
Materials Handling Equipment & Conveyor Systems
Chemical & Refinery Processing Plants
Paper, Food, Rubber & Textile Machinery
Hydro-Electric Gate Bearings and Accessory Equipment
Bridges

Lubrite self-lubricating bearings offer great versatility in hundreds of fields where dependability and superior performance are of prime importance.

Lubrite Bearings, with clean, permanent, maintenance-free self-lubrication are designed to withstand severe loadings, temperature extremes, submersion, corrosion and other adverse conditions.

Lubrite may be just the bearing you need in your designs to obtain better results.

Consult our Engineering Department on your application. No obligation.

Send for this free 20-page Lubrite Manual No. 55—it contains complete information, technical data and specifications about Lubrite Self-Lubricating Expansion Plates and Bushings. Write today!

Now Available—New Manual No. 56 with complete technical information about LUBRITE SELF-LUBRICATING BUSHINGS, BEARINGS & WASHERS.

Write for your copy.

LUBRITE DIVISION

MERRIMAN BROS., INC.

198 AMORY STREET, BOSTON 30, MASSACHUSETTS

Circle 120 on Reader-Service Card for more information

lens sets fed from a light source focus parallel beams on a flat disc which rotates at constant speed and has an odd number of holes. Both beams then are bundled parallel; one passes through the measuring channel, the other through a reference channel. The beams then are reflected back to semi-mirrors, which turn both light signals onto a common photocell.

The photocell receives a light pulse at a frequency $2f = 2\ nz$, where z is the number of holes in the flat disc, and n is its speed of rotation. As long as light absorption in both channels differs, the pulse sequence also contains a frequency $f = n\ z$. The photocell output voltage enters a turned circuit which amplifies f and filters out 2f.

In the reference channel, a ring-shaped gray wedge rotates at constant speed such that light passing through undergoes continuously changing absorption. During each rotation, measurement and reference channels have then the same total light absorption at one position of the wedge ring. At that point, the output voltage of the tuned amplifier becomes zero, which closes a switch admitting current from a stabilized highly resistant source into a condenser. The switch remains closed until the rotating wedge reaches a preset position. By integrating the current, the condenser generates a weakly pulsating d-c voltage which is proportional to the gray wedge rotation needed to balance light intensity in both channels. This angle in turn is a measure of smoke density.

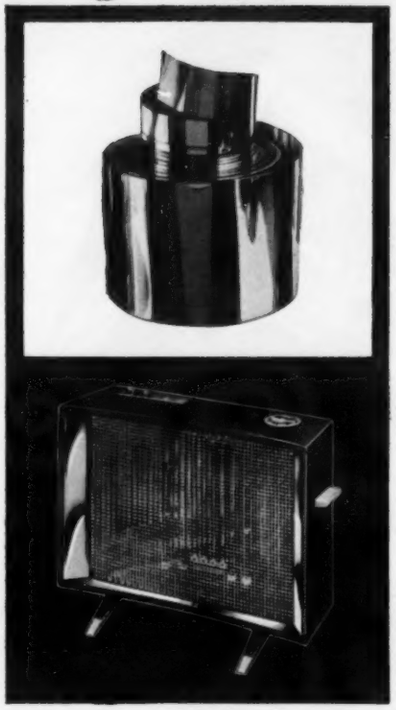
The smoke meter is a development of Erwin Sick Optik-Elektronic, Munich, Germany.

R.F.S.

Circle 121 on Reader-Service Card

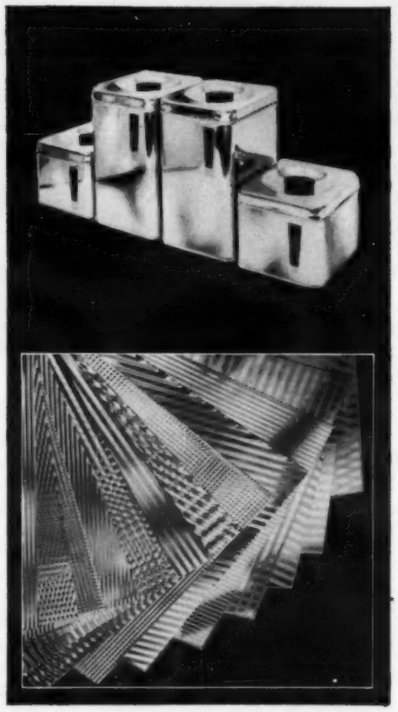
NICKELOID ...THE METAL WITH THE BRIGHT OUTLOOK

A modern metal, a metal for the times . . . functional, beautiful. At home always with high styling; equally responsive when called upon to serve in rough-and-tumble utilitarian and structural assignments. Nickeloid Metals brighten the profit outlook with plenty of eye-appeal and sales-appeal. You can choose from: glinty hard, mirror-like Chromium — soft, mellow, rich-looking Nickel — glowingly warm Copper — radiant, gold-like polished Brass. Nickeloid Metals add a shimmering luster to thousands of products used in home, in office, in commerce. These sheets and coils are pre-finished, ready for mass production.



HEATER

CANISTER SET



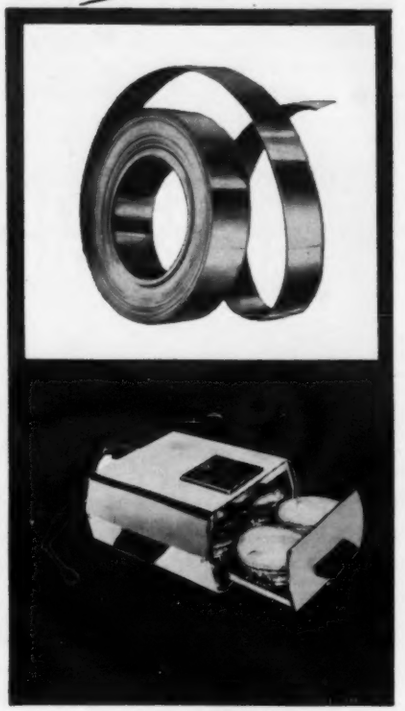


TABLE BROILER

Designer's Paradise

Here are exciting design materials . . . fascinating and versatile. Nickeloid Metals are eager and willing servants in the hands of the expressive and resourceful stylist. Their potentialities are as unlimited as the boundless imagination of the mind itself. The effects that can be created are immensely varied, so very flexible — giving you wide choices in luster, color, texture, patterns. The styling can be lavish or restrained; cool or warm; shimmering or satiny; soft or flashing. New vistas await exploration by the inventive, whether the use be decorative, structural, or for styling detail. Always, Nickeloid Metals are ductile, durable, workable, practical.

Details Sent Free

All who design, style, or manufacture will want to learn more about these versatile metals . . . will want to build a file of product information on the materials comprising the Nickeloid family of pre-finished metals. The data will include specifications and fabrication information. Metal samples for inspection are supplied for your file. Larger working samples for testing or for mockups will be supplied when details of the proposed use are furnished. A sales engineer will be glad to show you exciting new applications, to discuss metallurgical or fabrication problems, to help you develop cost comparisons. A letter will bring complete details.

NICKELOID METALS
SINCE 1898
NM

AMERICAN NICKELOID COMPANY

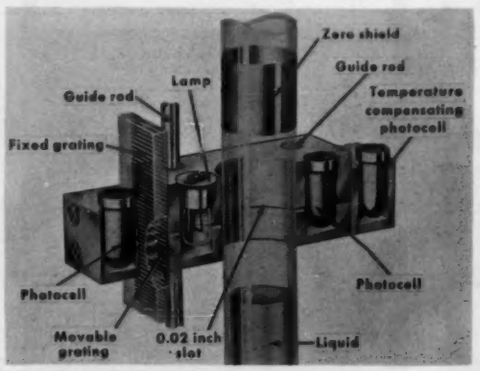
America's Pioneer Manufacturer of Pre-Finished Metals — Since 1898

Peru 9, Illinois — MILLS: Peru, Ill. and Walnutport, Pa.

SALES OFFICES in Chicago, New York, Cleveland, Buffalo, Los Angeles, St. Louis, Chattanooga, Boston, Philadelphia, Dallas, Salt Lake City, Seattle, Toronto. *See the yellow pages of your telephone directory.*

• **BY USING MOIRE-FRINGE** light diffraction patterns, a burette monitor determines height of liquid in a tube or burette to within 0.01 inch. Instrument can be arranged to feed information into an electronic counter or to a pen recorder.

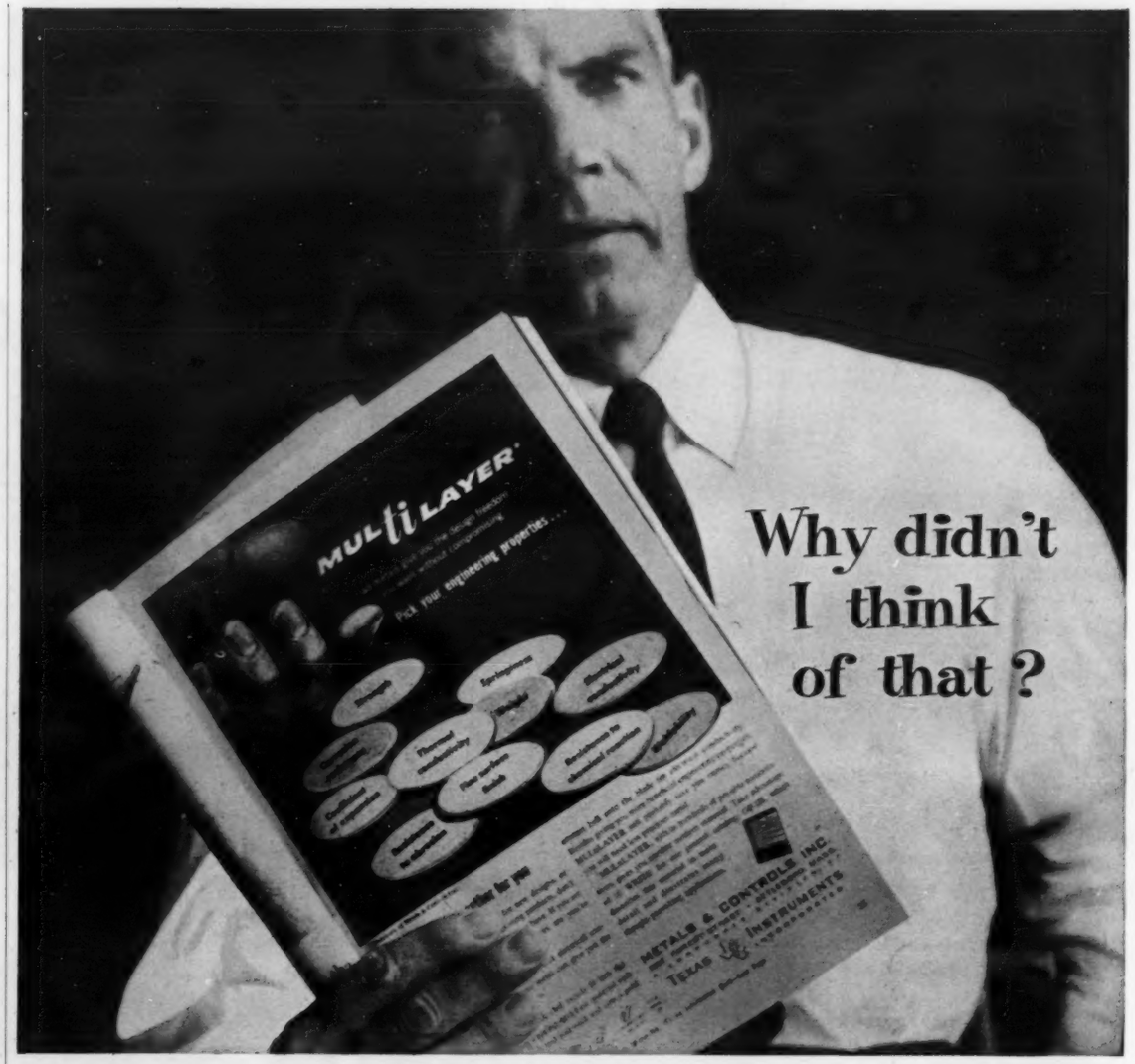
The monitor comprises a mobile "carriage" which is assembled around the burette and moves vertically on guide rods. One half contains a light source, a grating and a photocell. The other, on the opposite side of the burette, also contains a cell. In operation, the carriage is positioned at the top of the instrument. Light passes through a 0.02-inch slot in the carriage, and through the two gratings (one fixed to the carriage and the other attached to the stand) to the photocell. As the carriage moves, moire fringes are produced by the



relative movement of the two gratings so that the light to the cell is cut off once for each grating line (in this case, every 0.01 inch).

Although these light flashes to the cell occur all the time in the downward sweep, they are recorded only between a zero shield and the meniscus of the liquid. This is because the slot also can allow light to travel through the burette and fall on the other photocell (a third photocell is used as a temperature compensating device). At the start of the sweep, the zero shield cuts off this light, but as soon as the carriage moves down past this datum level, light falls on the cells which then actuate the counter circuit. On reaching the meniscus, light is cut off and the counting procedure ceases.

The automatic burette monitor was designed by the Atomic Weapons Research Establishment of the United Kingdom Atomic Energy Authority, London, England. R.W.E.M.



MULtiLAYER* Clad Metals Combine The Exact Operating Properties I Must Have.

This design engineer has just realized a fact we wish more people would discover. MULtiLAYER CLAD METALS PROVIDE MORE COMBINATIONS OF OPERATING CHARACTERISTICS THAN ANY SINGLE MATERIAL OR ALLOY.

If you need a spring with high conductivity, superior elastic properties, high temperature strength and easy weldability, no single spring alloy can satisfy all the requirements. MULtiLAYER clad spring metals can!

If a tube for chemical processing must have a clean, corrosion resistant, stainless steel surface, high thermo conductivity, plus high forming ductility for flaring and bending; no single material can satisfy all these requirements. MULtiLAYER clad tubing can!

Therefore, why compromise? Why be limited to only partial reliability in your components when, with MULtiLAYER clad metals, you can get maximum satisfaction?

You specify the engineering properties you need . . . we'll put the metals together for you — and even make the components in many cases. Find out about this modern design material. Call us or write for our illustrated brochure GP-1.

For materials and components come to Metals & Controls

*Trademark of Metals & Controls Inc.

TUBING WIRE STRIP STAMPINGS BALL WELDED ASSEMBLIES CONTACTS THERMOSTATIC METALS YOU NAME IT!

METALS & CONTROLS INC.
1209 FOREST ST. • ATTLEBORO, MASS.
A CORPORATE DIVISION OF
TEXAS INSTRUMENTS INCORPORATED

Circle 122 on Reader-Service Card for more information

MULtiLAYER*

clad metals combine all 4

- Thermal Conductivity
- Corrosion Resistance
- Strength
- Flexibility

in ONE strip

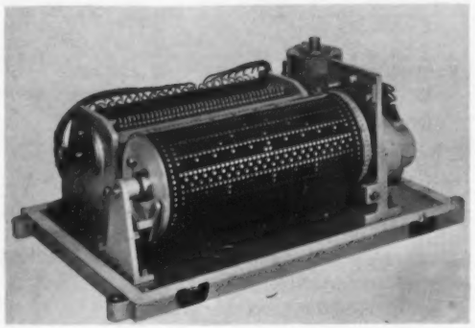
*Trademark of Metals & Controls Inc.

MULtiLAYER provided *all* these metal qualities for heat exchanger fins used in supersonic aircraft and missiles. Designed with a copper core for greater thermal conductivity, the fins thus increased the efficiency of the exchanger. Soft tempered stainless steel cladding was selected for its anti-corrosion properties, and for its conformability when wound around the exchanger in a spiral. It was also wetable by Coast Metal #53 brazing alloy to insure a continuous, high-strength connection. If the metal qualities required of your product are equally or more diverse, MULtiLAYER can solve *your* problem as well. Write for FREE LITERATURE describing physical and mechanical characteristics of this strip, and other specifications such as coefficients of expansion, forms and sizes, and weights.

METALS & CONTROLS INC.,
1209 Forest Street, Attleboro, Mass.

A CORPORATE DIVISION OF

TEXAS INSTRUMENTS INCORPORATED

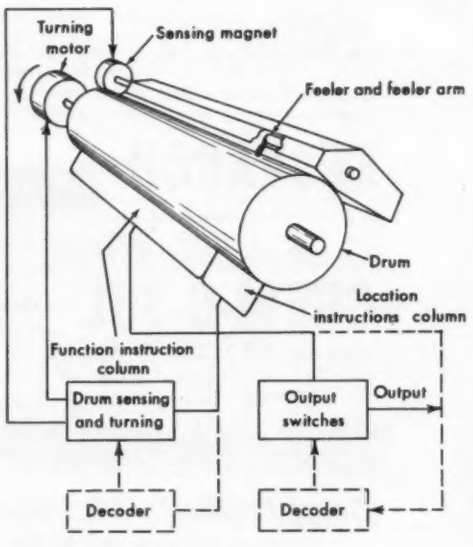


• **CORE OF A PROGRAMMING DEVICE** for automated machine tools is a drum on which a cylindrical bronze or PVC foil is mounted. Space is provided for punched holes in 50 lines (corresponding to 50 program steps) and 40 columns. Holes provide location and function instructions.

At each program step, magnet-actuated feelers with spring-loaded return linkage check each column; a hole triggers a switch and generates an output signal for the machine function assigned to that channel. After a line has been read simultaneously, a sequence-control mechanism deactivates the feeler magnet and feelers are retracted. A safety interlock permits the motor to advance the drum by one column only.

Effectiveness of the 40-column drum capacity can be increased by a decoding attachment which permits each column to be used for two types of information. The decoder decides to which output channel the information pertains. Reprogramming requires only a change in foils. The drum has a groove for each column. Ridges support the foil, while the grooves permit a feeler stroke without contact between feeler tip and drum.

Programmer AW 40/50 is a product of Brown, Boveri & Cie., Mannheim, Germany. **R.F.S.**



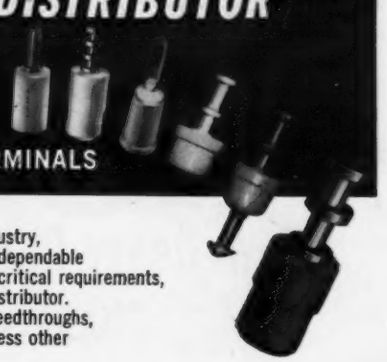
WHEREVER YOU ARE YOU GET THE

BEST FAST

from your **SEALECTRO DISTRIBUTOR**

PRESS-FIT

TEFLON TERMINALS

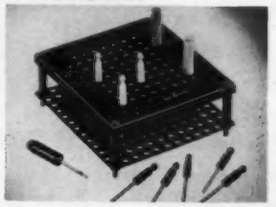


The terminal that revolutionized the industry, showing the way to faster, better, more dependable terminations compatible with the most critical requirements, is just as close as your local Sealectro distributor. He carries a wide choice of terminals, feedthroughs, test jacks, probes, stand-offs and countless other Press-Fit components.

CON-HEX® SUB-MINIATURE R.F. CONNECTORS

Your Sealectro distributor has them in stock—the superior sub-miniature r.f. connector, precisely made to assure optimum electrical and mechanical performance. Now available in Snap-On and Screw-On types in either Clamp-On cable connecting or the time-saving, cost-cutting new Crimp-On type.

SEALECTOBOARD® PROTO-KIT



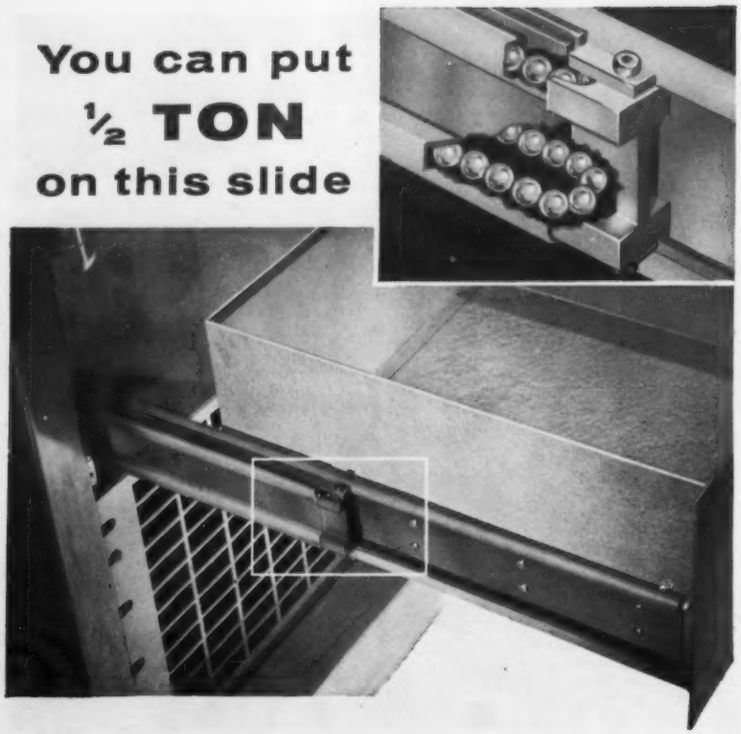
Brand-new, and better too! Complete programming systems that eliminate patch cords. Provide component interpositioning by merely pushing in a pin. The Sealectoboard concept is currently being used in many of the most critical electronic systems. Get a Proto-Kit from your Sealectro distributor today— it has 1001 uses!

✻ *Write for catalogs and listings of distributors...*

Sealectro CORPORATION
139 HOYT STREET • MAMARONECK, N. Y.
British Branch: Surrey, England

Circle 123 on Reader-Service Card for more information

You can put
½ TON
on this slide



New Heavy-Duty Slide from Chassis-Trak

Now you can rack-mount your heaviest electronic gear, yet keep it readily accessible for checking and servicing. A new heavy-duty Circulating Ball Slide, developed by Chassis-Trak, will easily support equipment in the 1000 lb. range, *even under extreme shock and vibration conditions.* Secret of the slide's strength is its Circulating Ball design *(see phantom view above).* Weight is distributed evenly over the balls which rotate in the direction of the pull, resulting in easy sliding action.

The new Circulating Ball Slide is permanently dry-lubricated with Poxylube 75, a bonded molybdenum disulfide film which assures smooth operation for the life of the slide. Easily assembled with standard hardware, the slide is available in lengths from 16" to 24" in two-inch increments and in lengths up to 60" in six-inch increments. Each track is only 1¾" wide and 3" high, requiring much less chassis space than other slides in this heavy-duty range.

Get full details on the new CB Slide today.

for further information contact:

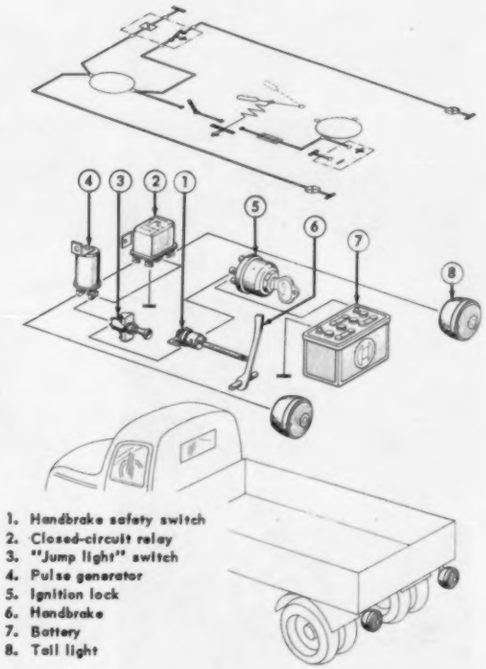
525 South Webster Ave., Indianapolis, Indiana

chassis Trak inc.

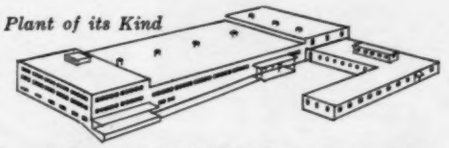
Circle 124 on Reader-Service Card for more information

•WARNING CIRCUIT switches current between left-hand and right-hand taillights of disabled vehicles at a rate of about 85 cpm. Resulting "jump light" is intended to forestall rear-end collisions.

As a safety factor, circuit can be energized only when handbrake is fully on. Separate jump light switch then feeds current through one of a pair of contacts to a pulse generator. Initially, a magnet-operated switching relay is closed and admits current to one taillight. As pulse generator begins to operate, the other contact receives a current pulse which breaks the relay circuit, turns off one taillight and lights the other. Robert Bosch GmbH, Stuttgart, Germany. R.F.S.



World's Largest Plant of its Kind



PLASTISOL HEADQUARTERS

3 reasons why...

CAPACITY — World's largest and most modern facilities for production of polyvinyl plastisols. Big-scale production gives you up to 15,000 lbs. in one batch; quality control guarantees stability from batch to batch.

RESEARCH — A completely equipped research laboratory enables us to custom-formulate a plastisol to meet strict specifications; often we can recommend the *right* plastisol from among the hundreds of **chem-o-sol** formulations already developed.

CHEM-O-SOL — More than a coating or molding compound, **chem-o-sol** is a new basic material for industry. Applied by dipping, casting, spreading, molding, wiping, spraying, or pressure forming, **chem-o-sol** has vastly broadened the ways in which plastisols may be used — to make a better product, to cut production time and costs.

Send for free bulletin, to Dept. T, Chemical Products Corporation, East Providence 14, Rhode Island.

Going Plastisols One Better... **chem·o·sol®**

Circle 125 on Reader-Service Card for more information

Meetings

Detroit, Mich. **Oct. 23-27**	NATIONAL METAL CONGRESS AND EXPOSITION, American Society for Metals, Cobo Hall.	**Houston, Tex.** **Nov. 9-13**	NATIONAL FUELS AND LUBRICANTS MEETING, Society of Automotive Engineers, Shamrock Hotel.
Boston, Mass. **Oct. 26-27**	THIRD ANNUAL SYMPOSIUM ON HIGH-SPEED TESTING, Plas-Tech Equipment Corp., Hotel Somerset.	**Phoenix, Ariz.** **Nov. 13-16**	SEVENTH ANNUAL CONFERENCE ON MAGNETISM AND MAGNETIC MATERIALS, American Institute of Electrical Engineers and the American Institute of Physics, Hotel Westward Ho.
New York, N. Y. **Nov. 1-3**	MEETING, Society for Experimental Stress Analysis, Hotel New Yorker.		
Chicago, Ill. **Nov. 6-8**	ATOMFAIR '61, Atomic Industrial Forum, Conrad Hilton Hotel.	**Los Angeles, Calif.** **Nov. 15-17**	NINETEENTH ANNUAL DISPLAY, Aerospace Electrical Society, Pan Pacific Auditorium.
Los Angeles, Calif. **Nov. 6-8**	SPECIAL TECHNICAL CONFERENCE ON NONLINEAR MAGNETICS, Institute of Radio Engineers, American Institute of Electrical Engineers, Statler Hilton Hotel.	**New York, N. Y.** **Nov. 26-Dec. 1**	WINTER ANNUAL MEETING, American Society of Mechanical Engineers, Statler Hilton Hotel.

DURANT

Electric Counters

COMPLETE LINE FOR HIGH SPEED, ACCURATE ELECTRONIC COUNTING

There's a DURANT electrically-actuated COUNTER designed just for your needs. Dependable, easy to read, easy to install on individual production equipment, or as original equipment on your new product. Get accurate counts at high, low, or intermediate speeds.

Durant Counters will give trouble-free service for many years, even under the most severe operating conditions.

PANEL MOUNT Mounting plate with knurled reset knob or tumbler lock reset — can be set in panel from front. Ideal for remote control.

Model SP-MF PREDETERMINED (lower left) May be pre-set to any number; when desired figure reached, an electric signal stops a machine, lights a light, or sets off an alarm. 600 CPM.

Send for CATALOG 55

DURANT MANUFACTURING COMPANY

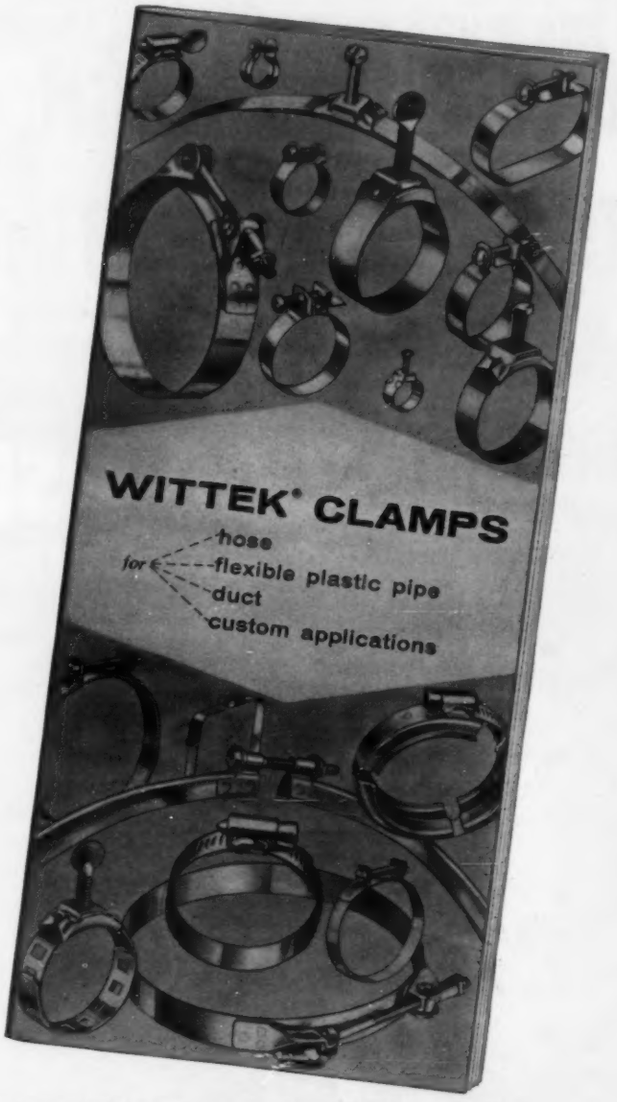
1992 N. Buffum Street
Milwaukee 1, Wisconsin

•

92 Thurbers Avenue
Providence 5, R. I.

Circle 126 on Reader-Service Card for more information

WHAT'S YOUR CLAMPING PROBLEM?



WITTEK has the answer . . .

Whatever your clamping problem, it's a safe bet that Wittek has the exact type and size clamp to do the job. Write for this new 16-page brochure on standard Wittek clamps and custom-made clamps.

Quality Clamps for Over 35 Years

WITTEK Manufacturing Co.
4350 West 24th Place, Chicago 23, Illinois

CLAMPS *for Every Application*

5056

Circle 127 on Reader-Service Card for more information

NEW NEW NEW NEW NEW NEW

NOW! 1½ TONS PER SQUARE INCH CONTINUOUS RATING

*Tested at 2½ tons per square inch

Pathon
3000 PSI
HYDRAULIC CYLINDERS

The New Pathon Series 3H Hydraulic Cylinders are not an adaptation or modification of existing models, but specially designed 3000 P.S.I. Cylinders, continuous service. The 3H Series is available in a wide range of bore sizes and standard mounting types. Like all other Pathon Cylinders, the 3H Series features:

- Single screw thread head attaching method
- Increased strength and fatigue lite
- Low Stress Concentration
- Compactness

Illustrated, Model 3H 33 incorporating spherical bearing at the pin connection.

FOR ADDITIONAL INFORMATION
WRITE—WIRE—PHONE TODAY

Pathon MANUFACTURING COMPANY
3823 PACIFIC AVE., CINCINNATI 12, OHIO

FLUID OPERATED AND CONTROL EQUIPMENT

Circle 129 on Reader-Service Card for more information

INDEX OF ADVERTISERS

Ace Plastic Co. 47
Aetna Ball & Roller Bearing Co., Div. of Parkersburg-Aetna Corp. 44
Airborne Accessories Corp. 138
Alan Wood Steel Co., Super Diamond Div. 36
Amchem Products, Inc. 50-51
American Chain & Cable Co., Automotive & Aircraft Div. 54
American Machine & Foundry Co., Potter & Brumfield Div. 135
American Nickeloid Co. 143
American Steel & Wire Div., United States Steel Corp. 58-59
American Viscose Corp. 131
Ampco Metal, Inc. 137
Anaconda American Brass Co. 43
Atlas Chain & Mfg. Co. 48
Auburn Mfg. Co. 125
AviSun Corp. 90

Barksdale Valves, Pressure Switch Div. 21
Borg-Warner Corp., Ingersoll Products Div. 133
Buffalo Weaving & Belting Co., Inc. 134

Cambridge Wire Cloth Co. 14
Carpenter Steel Co., Alloy Tube Div. 96
Cerro Sales Corp. 53
Chassis Trak, Inc. 146
Chemical Corp. 136
Chemical Products Corp. 146
Chicago-Allis Mfg. Corp. 149
Chicago Rawhide Mfg. Co. ..... Back cover
Chiksan Co., Subsidiary of Food Machine & Chemical Corp. 137
Clipper Belt Lacer Co. 140
Coes Knife Co. 150
Condé Pumps 115
Continental Motors Corp. 115
Controls Co. of America, Control Switch Div. 139
Copperweld Steel Co., Ohio Seamless Tube Div. 98-99
Crane Packing Co. 3
Crown Gear 110

Dillon, W. C. & Co. 23
Dodge Steel Co. 57
Dow Chemical Co., Metal Products Div. 60-61
Dudek & Bock Spring Mfg. Co. 133
du Pont, E. I. de Nemours & Co.,
Elastomer Chemicals Dept. ("Viton") 37
Fabrics Div. ("Fairprene") 89
Film Dept. ("Mylar") 45
Photo Products Dept. ("Cronaflex") 11
Polychemicals Dept. ("Delrin") 25-26
("Teflon") 113
Durant Mfg. Co. 147

Edgewater Steel Co. 151
Electric Regulator Corp. 97
Enjay Chemical Co., a Div. of Humble Oil & Refining Co. 42
Ex-Cell-O Corp., Rotac Div. 52

Fairchild Engine & Airplane Corp. 136
Federal-Mogul-Bower Bearings, Inc., Federal-Mogul Div. 22
National Seal Div. ..... Inside front cover
Ferguson Machine Co. 142
Firestone Tire & Rubber Co., Industrial Products Co. 114
Flexible Tubing Corp. ..... Inside back cover
Furane Plastics, Inc. 41

Garlock, Inc. 34
General American Transportation Corp. 104
General Electric Co., Chemical Materials Dept. 118-119
Gits Bros. Mfg. Co. 30
Globe Industries, Inc. 41
Goodrich, B. F. Co., Aviation Products Div. 124

Hamilton Mfg. Co., Drafting Equipment Div. 39-40
Haveg Industries, Inc., Taunton Div. 136
Heinze Electric Co. 151
Hendrick Mfg. Co. 23
Hollingsworth Co. 126
Holub Industries, Inc. 124

CAN Specialty PAPER

BREAK THROUGH YOUR DESIGN BARRIER?

Harnessed to the right design, paper has scored important advances in many new and improved products. That's because paper is low in cost, low in weight and low in mass per volume. Inertial resistance and kinetic energies are low. Yet paper is high in dielectric strength and volume resistivity, and can be made to conduct electricity, or to resist temperatures above the char point of cellulose.

Tell Us What You Want It To Do; We'll Tell You If Paper Can Do It.

We've been making paper for 150 years. Twenty years ago we decided to specialize on papers that no one had ever made before. That required creative chemists, physicists and technicians . . . a modern research laboratory with pulp-stock refining equipment and a complete Fourdrinier machine that can turn out an endless web of paper 20 inches wide. The accomplishments of this laboratory have surprised even us.

Today our production runs include the papers our own laboratory develops, as well as other specialty runs that demand close dimensional, chemical or physical limits and uniformity.

● Write for our free booklet, "Creative Imagination in Technical Papers." Tell us what you want paper to do. If your project shows promise of practical development, a sales engineer will call

Knowlton Brothers

Dept. 69, WATERTOWN, N.Y.

Circle 131 on Reader-Service Card

Hooker Chemical Corp. 103
Hoover Ball & Bearing Co. 121

Ideal Industries, Inc. 17
International Packings Corp. 129

Jones & Laughlin Steel Corp., Stainless and Strip Div. 105

Keuffel & Esser Co. 33
Knowlton Bros., Inc. 148
Kulka Electric Corp. 140

Laminated Shim Co., Inc. 64
Lau Blower Co., Main Div. 111
Lepel High Frequency Labs., Inc. 27
Lima Electric Motor Co. 20
Lincoln Engineering Co. 141
Lisle Corp. 48

Malayan Tin Bureau 134
McGill Mfg. Co., Inc. 115
Meehanite Metals Corp. 137
Meletron Corporation 46
Merriman Bros., Inc., Lubrite Div. 142
Mesa Plastics Co. 132
Micromatic Hone Corp. 150
Miniature Precision Bearings Co. 116
Minneapolis-Honeywell Regulator Co., Apparatus Control Div. 62-63
Minnesota Rubber Co. 1
Mobay Chemical Co. 55

National Vulcanized Fibre Co. 127

Ohio Rubber Co. 92-93
Ohmite Mfg. Co. 31

Parker-Hannifin Corp., Hannifin Co. Div. 15, 149
Pathon Mfg. Co. 148
Perkins Machine & Gear Co. 138
Permali, Inc. 110
Philadelphia Thermometer Co. 35
Pittsburgh Plate Glass Co., Fiber Glass Div. 123
Plastic & Rubber Products Co. 32
Polymer Corp. 49
Post, Frederick, Co. 2
Power Instruments Inc. 116
Poxylube, Inc. 35
Pressed Steel Tank Co. 61

Raybestos-Manhattan, Inc., Adhesives Dept. 109
Manhattan Rubber Div. 108
Packings Div. 109
Revere Copper & Brass, Inc. 106-107
Rockwood Sprinkler Co. 35
Ross Operating Valve Co. 115

Scott Paper Co., Industrial Foam Div. 29
Sealectro Corp. 145
Simmons Fastener Corp. 128
Skinner Electric Valve Div. of Skinner Chuck Co. 101-102
Spraying Systems Co. 23
Square D Co. 125
Standard Pressed Steel Co., Industrial Fastener Div. 10, 27
Stanpat Co. 132
Stephens-Adamson Mfg. Co., Standard Products Div. 133
Syncro Corporation 47
Synthane Corp. 16

TA Mfg. Corp. 151
Texas Instruments Incorporated, Metal & Controls Div. 144-145
Tomkins-Johnson Co. 95
Torrington Co. 91
Tranter Mfg., Inc. 53
Tuthill Pump Co. 24
Twin Disc Clutch Co. 38

Uniform Tubes, Inc. 49
United Shoe Machinery Corp., Fastener Div. 28, 97
United States Steel Corp., American Steel & Wire Div. 58-59
U. S. Graphite Co. 94

Vickers, Inc., Div. of Sperry Rand Corp., Machinery Hydraulics Div. 18-19
Vlier Engineering Corp. 100

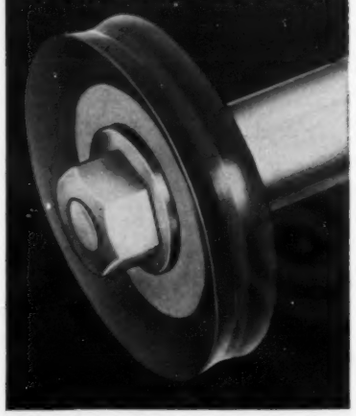
Ward Leonard Electric Co. 152
Whitey Research Tool Co. 117
Wittek Mfg. Co. 147

REDUCE COSTS, IMPROVE PRODUCT QUALITY!

use

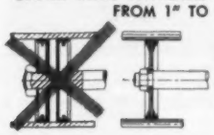
CHICAGO-ALLIS

ONE-PIECE DOUBLE ACTING PISTON CUPS



For cylinders, pumps, and valves . . . air, water, or oil. This is a piston type double-cup packing in a single unit . . . specially compounded rubber is bonded to metal disc of brass plated steel or solid brass. Lips are designed to maintain uniform pressure on the cylinder walls, insuring constant sealing action. Serving the same purpose as far more complicated and expensive pistons, Chicago-Allis piston cups are simple in design, economical, and provide long life and dependable service.

STOCK SIZES AVAILABLE FOR CYLINDERS FROM 1" TO 12"



Simplify design... use one piston type cup that replaces piston and two seals

Write today for Bulletin 108

CHICAGO-ALLIS

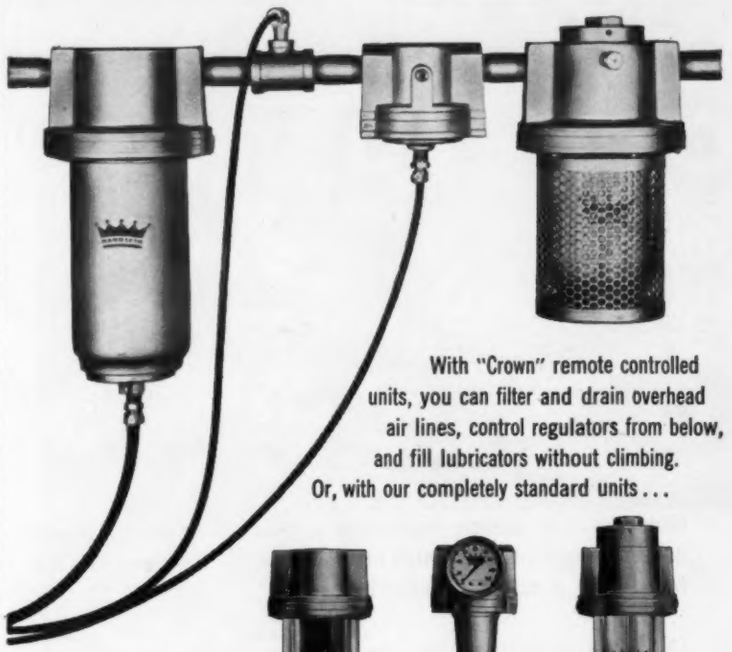
MFG. CORP.

129 N. GREEN ST. CHICAGO 7, ILL.

Circle 132 on Reader-Service Card

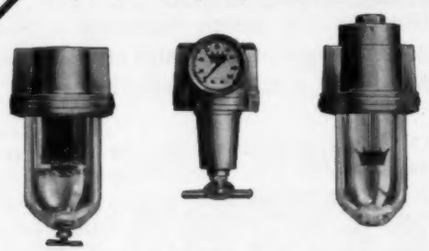
HANNIFIN *Crown*

delivers air the way you want it!



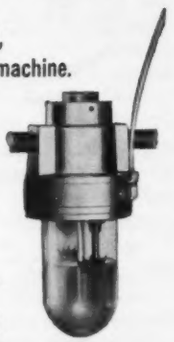
With "Crown" remote controlled units, you can filter and drain overhead air lines, control regulators from below, and fill lubricators without climbing.

Or, with our completely standard units . . .



. . . you can provide just the right amount of filtered, regulated and/or lubricated air right at your machine.

NEW! **PULSE-LUBE . . . for off-beat air flow**



If air flow is uphill or light or so infrequent that air-borne lubrication won't solve your problem, you can deliver oil just where you need it, in the exact amount you need, through a tiny flexible tube with new "Crown" Pulse-Lube . . .

All these "Crown" developments are detailed and described in a new, comprehensive "Crown" catalog (our Bulletin 0400-B1). We'll be happy to send you one.

PARKER-HANNIFIN

HANNIFIN COMPANY DIVISION

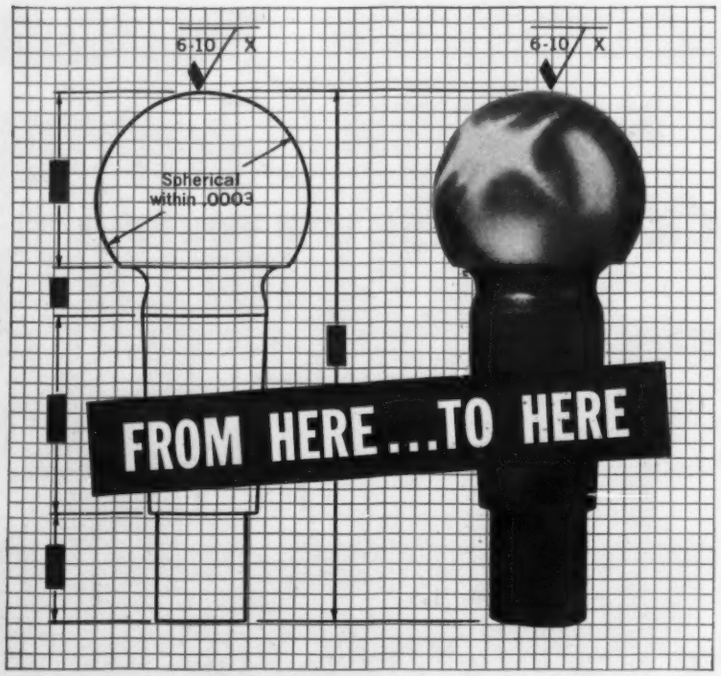
535 South Wolf Road • Des Plaines, Illinois

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS

3071-PH

Circle 133 on Reader-Service Card for more information

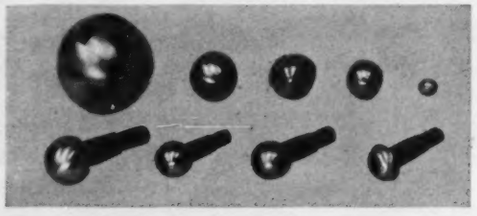


in just 3 steps

Now you can design truncated spheres with much closer spherical and surface finish tolerances and find them quickly realized in actual production!

Step 1, cast, forge or cold-head the part; step 2, mill the sphere; step 3, Microhone the sphere. Steps 2 and 3 combine new, specially developed milling and Microhoning, machines which generate sphericity within .0003" tolerance and a controlled microinch finish of 6-10 rms. (Former methods were hard pressed to productively obtain sphericity within .002").

This new method can be applied to any truncated sphere which has a shank or bore to permit holding without touching the sphere. Micromatic will be happy to demonstrate how you, too, can tighten up design tolerances on spheres and also enjoy dramatic production savings. Just call or drop us a line.



Shown here are some typical truncated spheres currently being processed by the Micromatic Method.

MICROMATIC HONE CORPORATION

8100 SCHOOLCRAFT • DETROIT 38, MICHIGAN

Circle 134 on Reader-Service Card for more information

INDEX OF NEW PRODUCTS AND LITERATURE

NEW PRODUCTS

MECHANICAL — Page No.

Actuators, constant-torque rotary 99
Clutches, nylon-gear magnetic 96
Counters, subminiature 96
Encoders, magnetic 98
Fasteners, self-locking 99
Pins, quick-release 97

ELECTRICAL

Modules, thermoelectric cooling/heating 103
Pins and sockets, microminiature 103
Rectifiers, 70-amp 100

MATERIALS

Cables, electronic hookup 95
Cam followers 95
Ceramics, piezoelectric 93
Coatings, adhesive 64
Coatings, epoxy 62
Cup packings 60
Drawing leads 64
Foam, polyurethane 92
Foil, etched 63
Glass and ceramic parts 62
Grommets, miniaturized 59
Insulation, urethane foam 61
Lacing cord, epoxy-glass 56
Laminates, copper-clad 91
Lubricants, dry-film 57
Markers, wire identification 56
Marking systems, permanent 92
Molding compounds, electrically conductive (samples) 57
Plastic lead, smudgeproof 60
Resins, general-purpose 89
Seals, O-ring 61
Tape, low-shrinkage 93
Transistors, metallized ceramic-base 89
Tubing, coded insulated (sample) 56
Tubing, "Teflon" 91
Tubing, transparent PVC (samples) 58
Weatherproofing, silicone 59
Wiring harness 94

EQUIPMENT

Adapters, tube base 106
Application kits, electromechanical 108
Breadboarding kits 110
Gages, height 107
Marine channel kits 105
Meters, ampere hour 111
Meters, power 109
Microscopes, precision 106

(Continued on next page)

When you build new machines or rebuild old equipment you can **SAVE** MATERIAL, TIME, LABOR, MONEY with

COES MICRO-WEAR STRIPS

Master scraping plate at Norton Company with Micro-Wear Strips.

Micro-Wear Strips Applied to the cross slide on the knee of a milling machine.

These are just two of the many applications that help reduce the manufacturers' original cost.

These strips are uniformly hardened to minimum 64 Rockwell C hardness and can be manufactured to your exact specifications, ready for application with Coes #945 Epoxybond adhesive or with holes for hold-down screws.

Send for latest technical information

COES KNIFE COMPANY
73 COES ST.
WORCESTER, MASS.

COES MICRO GROUND

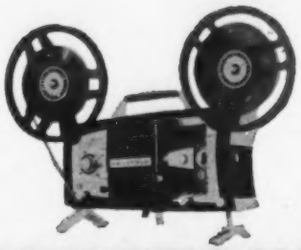
Circle 135 on Reader-Service Card

Ratchets 105
Templates, drafting 104
Torquemeters 104

NEW LITERATURE

MATERIALS

Capacitors, ceramic 119
Castings, plaster mold 118
Ceramics, metallized 118
Coating, nickel alloy 119
Fluids, silicone 116
Foam products 119
Handbook, 'Plexiglas' 116
Insulation, electrical 118
Metal, finishing 118
Metals, magnetic 119
Optics, plastic 119
Packings, leather 118
Phenolics, designing with 119
Plastic, acetal 117
Plastic, laminated 118
Plating, acid gold alloy 119
Polyvinyl chloride 118
Rod, beryllium copper 118
Rubber, silicone 119
Seals and packings, urethane 119
Selector, electrical resins 118
Sheet, patterned aluminum 117
Steel, high strength 118
Tubing, plastic 117
Urethanes 119



KEYSTONE
is keen on high starting torque, variable speed of
HEINZE SMF MOTORS

Motors for Keystone Projectors must have reliable high starting torque and variable speeds. Heinze SMF Universal Motors meet these needs precisely. Motors are available in hp ratings from 1/10 to 1/30; load speeds of 5,000 to 7500 rpm; 115 V AC/DC or other voltages in AC or DC. This is just one of a comprehensive line of compact Heinze Universal Motors. They feature high starting and running torque, are versatile to allow all types of mounting arrangements and modifications, are uniform in quality, keyed to high production, and competitively priced.

Write for complete catalog.

HEINZE ELECTRIC COMPANY
685 Lawrence St.
Lowell, Mass.
SUB-FRACTIONAL HORSEPOWER MOTORS AND BLOWERS

Circle 136 on Reader-Service Card

TA "King-Size" Instrument Cases 4 PAGES

TA Standard Instrument Cases 20 PAGES

Learn how TA's new predesigned Instrument Cases solve *your* equipment housing problems.

SEND FOR YOUR FREE COPIES!

THESE EXCLUSIVE FEATURES—STANDARD WITH TA—SAVE YOU TIME AND COST

1. Predesigned panel-layouts for perfect fit.
2. Large selection of standard sizes and styles.
3. Wide choice of standard handles, access doors, panels, and other accessories.
4. All standard Cases include panel gaskets.
5. All Cases protected by air relief valves.
6. Available in depths from 2½ to 18 inches.
7. Fast delivery (prototypes in 4 weeks).
8. No tooling charges on standards.
9. Precision quality.
10. Reinforced aluminum construction.
11. TA Cases are color matched to, and integrated with, the instruments they are to contain.

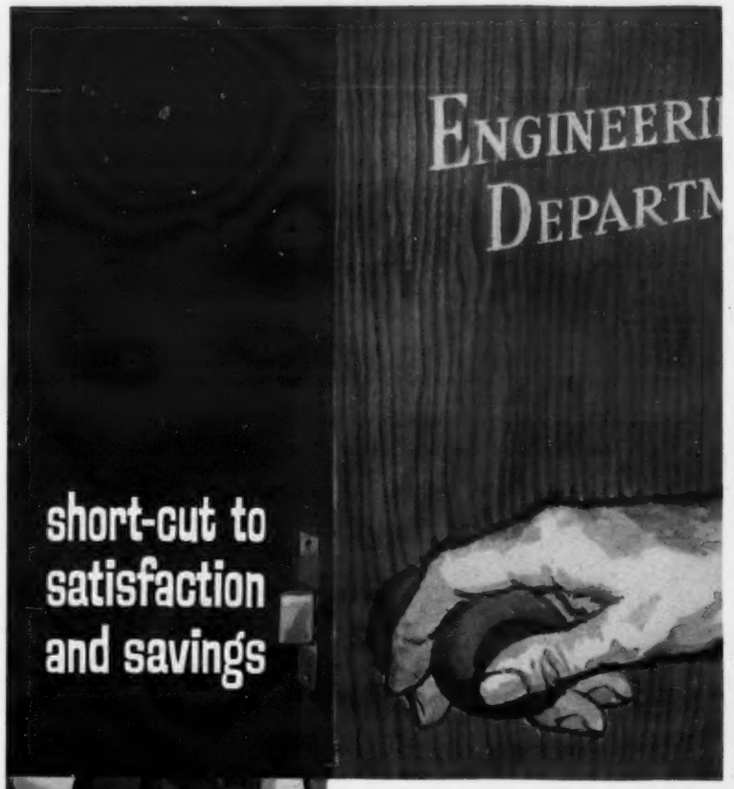
INSTRUMENT MANUFACTURERS: If you make portable instruments or equipment, you can't afford *not* to investigate the TA line.

TA Cases come in a diversity of standard lid sizes, and are sold at proprietary prices. During assembly the depth can be cut to your exact specifications. Or, if you like, TA will furnish you free vellums and templates so you can save yourself money by designing your product to fit one of the many standard sizes.

Start saving big money right away. Send for your valuable free TA manuals *today!*

TA Mfg. Corp. 4607 Alger Street • Los Angeles 39, Calif.
(or call CH 5-3748)
TWX 9863 Glendale, Calif. • WUX CAT Los Angeles, Calif.

Circle 145 on Reader-Service Card for more information



Rolled Steel Rings of simple or complex cross-section can be produced by the Edgewater process, in diameters from 5 to 145 inches. Materials include carbon steel, stainless and heat-resisting alloys, tool steel.

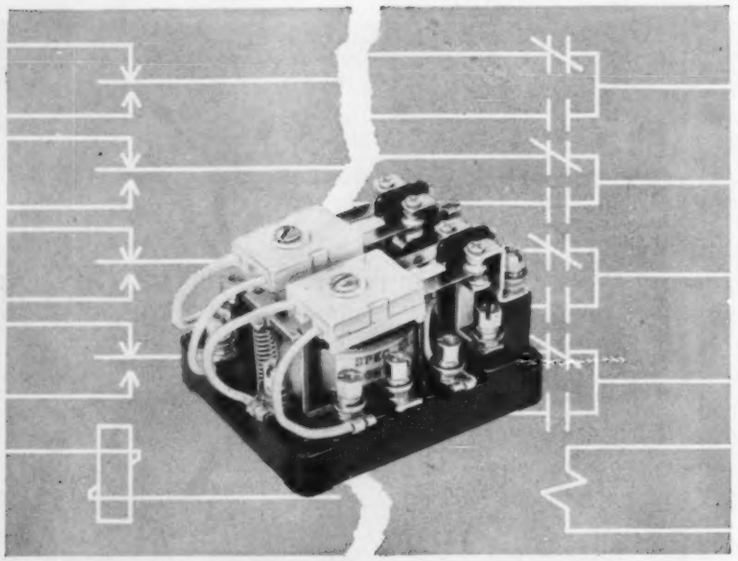
Edgewater's first step in answering an inquiry for rolled steel rings is to have Engineering check the proposed design for possible modifications that would improve the ring and/or reduce the price. This assures a good design—one that meets all requirements, at lowest cost.

Forged from solid blocks of steel and rolled on a powerful ring mill, Edgewater weldless rings are formed to cross-section shapes so close to finished dimensions that very little machining is needed. Close tolerances mean less labor, less scrap loss, lower overall costs. The Edgewater rolling process assures maximum strength, toughness and uniformity. Send drawings for recommendations and prices.

INTERESTING description of the ring-rolling process is given in this brochure, **Edgewater Rolled Steel Rings.** We will be glad to send you a copy.

Edgewater Steel Company
P.O. Box 478 • Pittsburgh 30, Penna.

Circle 137 on Reader-Service Card for more information



NEW WARD LEONARD, 4-POLE RELAY

more compact, more economical than ever

...for relay circuits up to 10 amps

Here's a new 4-pole, double-throw, power-handling relay that measures only 2-5/8" W x 3-1/8" H x 1-29/32" D and weighs only 11 ounces . . . only slightly larger than previous 3-pole relays, yet its contacts are rated up to 10 amps, non-inductive.

It's the new W/L NYLINE Bulletin 110 relay—another Ward Leonard relay you can stake your reputation on.

Look at these outstanding design features for long trouble-free life: Simplified nylon contact finger support to insure full electrical spacing and simplified contact placement . . . self-cleaning, self-aligning, silver contacts—for positive make and break with superior wiping action and follow . . . flexible silicone insulated leads connecting leaf-spring contact fingers and terminals . . . and many other big features.

You'll find complete information on the new 4-pole NYLINE relay (plus 2- and 3-pole models) in Ward Leonard Bulletin 110. Write for your copy and a list of stocking distributors today. Ward Leonard Electric Co., 26 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada, Ltd., Toronto.)

I-8

ENGINEERING DATA—4-POLE DT RELAY

CONTACT RATINGS

Volts	D.C. Amps.*		A.C. Amps.*	
	N.O.	N.C.	N.O.	N.C.
0-24	10	10	10	10
25-125	1	1	10	10
126-250	..	..	10	10

COIL VOLTAGES: 6, 8, 10, 12, 24, 32, 48, 115, 230

AVG. COIL WATTS: 3.5 D.C.; 5.0 A.C

PICK-UP: 85% or less of rated coil voltage.

WEIGHT: 11 ounces.

DIMENSIONS: 2-5/8" W x 3-1/8" H x 1-29/32" D.

*Ratings are non-inductive.

RESULT-ENGINEERED CONTROLS

WARD LEONARD ELECTRIC CO. MOUNT VERNON NEW YORK

RESISTORS • RHEOSTATS • RELAYS • CONTROLS • DIMMERS

Circle 138 on Reader-Service Card for more information

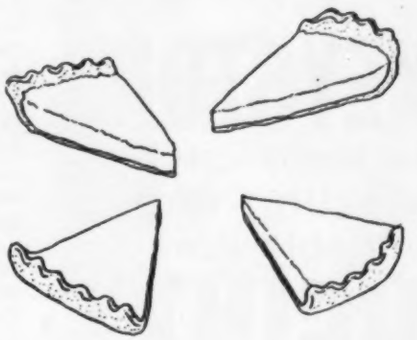
PLANS AND CROSS-SECTIONS

100,000 Pieces of Pi
3.14159265.....5493624646

You undoubtedly recognized the first group of digits above, but you probably won't recognize the latter group. These digits are digits 99,990 through 100,000 of the value of "pi".

Drs. J. W. Wrench, Jr., and Daniel Shanks used an electronic computer to determine the value of pi to 100,000 digits. Computation was done by two methods as a check on how accurately a computer can compute, and, fortunately, both methods gave the same answers. It took the IBM 7090 Computer eight hours to make the calculations. In comparison, it would take a man, working eight hours a day without error on a desk calculator, approximately 30,000 years to make the same computation.

The value of pi had previously been calculated to 16,167 decimal places by use of computers in Paris.



Drs. Wrench and Shanks are of the U.S. Navy's David Taylor Model Basin. Don't get the idea that the calculation applied to the 100,000 place is not of value. It has been pointed out that one use is in statistical studies of the distribution of digits.

Slap and Thump

James Sidles of Cuyahoga Falls, Ohio, has developed a slap and thump tester. The sand box device is "especially useful" in running comparative tests on vibration caused by different sets of tires.

The device consists of a wooden base holding a screened sieve with a trap directly below it. The sieve is filled with tiny pellets.

As the car moves, with the device mounted on the floor, wheel vibrations are picked up in the base and side supports, causing the pellets to drop through the screen into the trap. The number of pellets present at the end of the ride is used as a basis for measuring vibration effects. Mr. Sidles, who is with Firestone Tire and Rubber Co., recently patented the device.

First tell me your idea so we can have a good laugh, and then we can go on from there.

MAIL THE CARD TODAY

ADVERTISEMENTS

1	2	3	4	5	151	152	153	154	155
6	7	8	9	10	156	157	158	159	160
11	12	13	14	15	161	162	163	164	165
16	17	18	19	20	166	167	168	169	170
21	22	23	24	25	171	172	173	174	175
26	27	28	29	30	176	177	178	179	180
31	32	33	34	35	181	182	183	184	185
36	37	38	39	40	186	187	188	189	190
41	42	43	44	45	191	192	193	194	195
46	47	48	49	50	196	197	198	199	200
51	52	53	54	55	201	202	203	204	205
56	57	58	59	60	206	207	208	209	210
61	62	63	64	65	211	212	213	214	215
66	67	68	69	70	216	217	218	219	220
71	72	73	74	75	221	222	223	224	225
76	77	78	79	80	226	227	228	229	230
81	82	83	84	85	231	232	233	234	235
86	87	88	89	90	236	237	238	239	240
91	92	93	94	95	241	242	243	244	245
96	97	98	99	100	246	247	248	249	250
101	102	103	104	105	251	252	253	254	255
106	107	108	109	110	256	157	258	259	260
111	112	113	114	115	261	262	263	264	265
116	117	118	119	120	266	267	268	269	270
121	122	123	124	125	271	272	273	274	275
126	127	128	129	130	276	277	278	279	280
131	132	133	134	135	281	282	283	284	285
136	137	138	139	140	286	287	288	289	290
141	142	143	144	145	291	292	293	294	235
146	147	148	149	150	216	297	298	299	300

NEW PRODUCTS

301	302	303	304	305
306	307	308	309	310
311	312	313	314	315
316	317	318	319	320
321	322	323	324	325
326	327	328	329	330
331	332	333	334	335
336	337	338	339	340
341	342	343	344	345
346	347	348	349	350
351	352	353	354	355
356	357	358	359	360
361	362	363	364	365
366	367	368	369	370
371	372	373	374	375
376	377	378	379	380
381	382	383	384	385
386	387	388	389	390
391	392	393	394	395
396	397	398	399	400
401	402	403	404	405
406	407	408	409	410
411	412	413	414	415
416	417	418	419	420
421	422	423	424	425
426	427	428	429	430
431	432	433	434	435
436	437	438	439	440
441	442	443	444	445
446	447	448	449	450

(Please do not abbreviate)

Name_____

Title_____

Company_____

Division_____

Address_____

City_____ State_____

Design News, September 29, 1961
This Card Good Until
December 4, 1961

LITERATURE

451	452	453	454	455
456	457	458	459	460
461	462	463	464	465
466	467	468	469	470
471	472	473	474	475
476	477	478	479	480
481	482	483	484	485
486	487	488	489	490
491	492	493	494	495
496	497	498	499	500
501	502	503	504	505
506	507	508	509	510
511	512	513	514	515
516	517	518	519	520
521	522	523	524	525

☐ Employment ads—please give home address

_____

_____

_____

_____

_____

FREE REPRINTS

526	527	528	529	530
531	532	533	534	535
536	537	538	539	540
541	542	543	544	545

OTHERS

546	547	548	549	550
551	552	553	554	555
556	557	558	559	560
561	562	563	564	565

Postage Will Be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY MAIL

FIRST CLASS PERMIT No. 381, Sec. 34.9 P. L. & R., ENGLEWOOD, COLORADO

Reader-Service Department

Design News

ENGLEWOOD, COLORADO

DESIGN NEWS

NBP BPA

SALES OFFICES

BOSTON: H. W. James, 520 Boylston St., Suite 303, Boston 16, Mass. COmmonwealth 6-2310.

CHICAGO: R. E. Hall, Jr., *Regional Mgr.*, E. G. Kebler, H. J. Stouffer, G. H. Hale, 20 N. Wacker Drive, Chicago 6, Illinois. CEntral 6-7883.

CLEVELAND: J. V. Carey, *Regional Mgr.*, D. R. Buckner, 11955 Shaker Blvd., Cleveland 20, Ohio. SWeetbriar 1-5414.

DENVER: Executive Offices, 3375 S. Bannock St., Englewood, Colo. SUnset 9-0571.

DETROIT: J. V. Carey, *Regional Mgr.*, M. R. MacGuidwin, 19600 W. McNichols Rd., Detroit 19, Mich. KEnwood 7-3740.

LOS ANGELES: R. C. Wynkoop, *Regional Mgr.*, A. H. Parkes, 6399 Wilshire Blvd., Los Angeles 48, Calif. OLive 3-9720.

NEW YORK: J. B. Gellatly, *Regional Mgr*, G. A. Reilly, R. M. Gainey, 60 E. 42nd St., New York 17, N. Y. YUkon 6-2030.

PHILADELPHIA: W. M. Platt, *Regional Mgr.*, T. L. Carey, 6 Penn Center Plaza, Philadelphia 3, Pa. LOcust 3-0812.

PITTSBURGH: W. M. Platt, *Regional Mgr.*, F. K. Esherick, Jr., One Gateway Center, Pittsburgh 22, Pa. ATlantic 1-8822.

BUSINESS STAFF

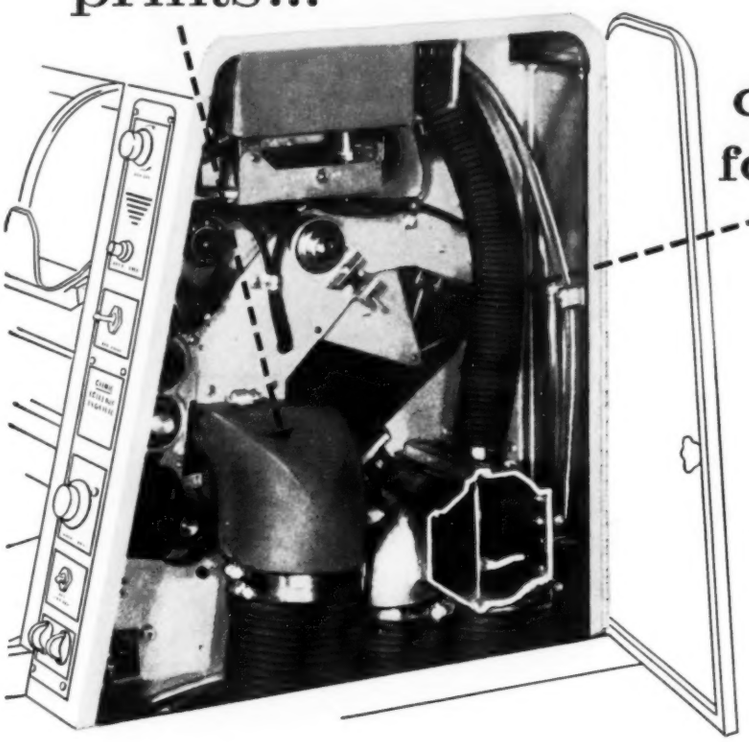
J. C. Crawford. . Manager of Sales Promotion
R. K. Kinnes. . Manager, Circulation Services
3375 S. Bannock St., Englewood, Colo.

Published bi-weekly by Rogers Publishing Co., Inc., a Subsidiary of Cahners Publishing Co., Inc. **Norman L. Cahners,** Chairman of the Board; **E. S. Safford,** President; **Saul Goldweitz, G. F. Taylor,** Vice Presidents. Editorial, Advertising and Subscription Offices: 3375 S. Bannock, Englewood, Colo. Telephone: SUnset 9-0571. Printed at 85 W. Harrison St., Chicago 5, Ill. Accepted as Controlled Circulation Publication at Chicago, Illinois. Send form 3579 to subscription offices.

Circulated to design engineers in the U.S. original equipment manufacturing industry—plants with more than 20 employees and which manufacture machinery or equipment of their own design. Design engineers responsible for specification of components, materials or engineering department may receive DESIGN NEWS without charge. Written request on company letterhead required. Subscriptions to others in continental United States, $1 per copy. $20 per year. Please send requests for subscriptions and change of address to Circulation Manager, DESIGN NEWS, Englewood, Colorado.

In the Lancer Whiteprinter, Flexible Tubing

1...provides suction to separate originals from prints...



2... conveys air for cooling...

3... exhausts heat and fumes

Proof that Flexible Tubing can solve a wide range of design problems

Copymation, Inc., designers of the LANCER Dry Process Whiteprinter, had to solve three tough air handling problems: how to provide suction . . . how to convey air for cooling . . . how to exhaust heat and fumes — all in a very limited space!

Solution to all three problems: a rugged nonmetallic duct with a wire helix — Flexible Tubing's "Flexflyte." Flexflyte is air tight and non-collapsing — provides strong, continuous suction for separating originals from prints. Flexflyte is lightweight and highly flexible — easily conveys air through cramped areas. Flexflyte is flameproof and corrosion-resistant — safely exhausts heat and fumes. Perfect example of the design problems solved with Flexible Tubing!

If you work on any kind of original equipment involving the handling of air, liquids or light solids, there's a Flexible Tubing product that can do the job! It's at work today in electronic computers, vacuum cleaners, farm combines and hundreds of other places. Consult your factory-trained Flexible Tubing regional sales engineer. He'll be glad to give you technical assistance. Or write for Catalog 10-19.

Flexible Tubing Corporation

209 New Whitfield St., Guilford, Conn.

Anaheim (Los Angeles) • Hillside (Chicago)
Atlanta • Cleveland • Dallas • Denver • San Francisco • St. Louis • Wichita

Circle 139 on Reader-Service Card for more information

C/R DESIGN NOTES

C/R offers new bonded CRS Seal design in standard sizes — without premium tooling charges

Design Advantages

The CRS Seal now provides a new level of C/R Seal performance through its simple, bonded design. There are no internal parts to misalign, no avenues for internal leakage. The shell and sealing member are integral — bonded securely for the long life of the seal. The CRS Seal incorporates a sealing member with both improved lip configuration and improved concentricity. The sealing member has been strengthened over former designs by placing more material at points of major flex and wear — and without increased shaft loading.

Designer Advantages

The CRS Seal gives the designer one, basic, rugged shaft seal design which may be applied with high reliability to the great majority of common shaft seal applications — particularly in industrial, automotive, farm, and off-the-road equipment.

Four basic design variations are available. As you can see, these provide an auxiliary sealing lip, where it may be required, or provide extra rugged shell construction where conditions suggest the need to protect the seal lip against assembly damage — or where large, heavy-duty shafts are being sealed.

Selection of the new C/R Type CRS Seal gives the designer and buyer major advantages over special seals: shorter lead time on orders, simpler specification, savings in time and money, and improved assembly quality and reliability.

Operating Maximums*

Shaft Speeds	3600 fpm (single lip) 2500 fpm (double lip)
Run-out	.015" TIR dynamic eccentricity .010" static eccentricity
Temperature	−30 to +275°F. (225°F. in EP lube)
Pressure	5 psi (single lip) 10 psi (double lip)
Media	Oil, grease, fuel, water

Not all conditions present in one application

New, Improved Compound

Standard sealing members for the C/R Type CRS Seal are molded of a new Sirvene synthetic rubber compound having markedly superior sealing and wearing properties. It is a Buna-N-based material with low-friction characteristics. The CRS Seal can also be furnished in the usual special materials such as acrylates, Silicones, and butyls. Shells are of standard steel, but can be provided in corrosion-resistant materials on special order.

Consult C/R Engineers

For assistance on the application of the new CRS — or on any oil seal problem, get in touch with C/R Oil Seal Engineers. They're specialists in fluid sealing — and will gladly cooperate with you.

For More Design Data:

You will want the complete design data on the new CRS Seal. Write for our Bulletin CRS-100. It gives you the complete list of standard sizes, widths, O.D.'s, shell thicknesses and sealing lip heights. You will want it to compare and then specify C/R's CRS Seal.

CHICAGO RAWHIDE MANUFACTURING COMPANY

1211 Elston Avenue • Chicago 22, Illinois

Offices in principal cities

See your telephone directory

In Canada: Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario

Export Sales: Geon International Corp., Great Neck, New York

Circle 140 on Reader-Service Card for more information